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KNOWLEDGE
AN
ILLUSTRATED MAGAZINE
OF
SCIENCE, LITERATURE, & ART

LONDON: NOVEMBER 1, 1888.

TO OUR READERS.

THE representatives of the late Mr. R. A. Proctor, acting for the benefit of his widow and children, have agreed for the sale of KNOWLEDGE to Messrs. W. H. Allen & Co., publishers, of Waterloo Place, who have already received promises from many of Mr. Proctor's scientific friends to contribute to its pages. The original idea of Mr. Proctor with respect to this publication will be kept in view by the Editors, who will endeavour to make it a magazine of science, plainly worded and exactly described.

The ablest exponents of science will be invited to contribute articles and letters to its pages, and more space than hitherto will be devoted to Physics and Physical Geography, and to Natural History, including Botany. The space devoted to Astronomy must be somewhat curtailed, but it will probably still remain the leading feature of the magazine.

The Editors will use their discretion in repressing in the papers accepted for publication Anglicised Latin when, as is usually the case, the same idea can be as accurately expressed in ordinary words. Reviews of new scientific books and papers read before scientific societies will be given in a popular form, with illustrations, and scientific news will as far as possible be translated into the language of ordinary life.

The publishers have purchased from Mr. Proctor's representatives a great number of unpublished articles by Mr. Proctor, which will be produced from time to time, but papers referring to politics and religion will be avoided as not coming within the field of KNOWLEDGE as originally mapped out.

The columns for chess and whist (regarded as scientific games) will be continued, and a correspondence section will be opened for full and free discussion on matters likely to be of interest to general readers.

Those who approve of the plan above sketched out and wish to see

KNOWLEDGE grow from more to more,

can help us by making the magazine known to their friends, and introducing it to clubs and institutes where it is not already subscribed for.

MR. PROCTOR'S LAST ARTICLE.

READERS of KNOWLEDGE will be interested in seeing the last article written by Mr. Proctor only a few days before he started for New York, where death overtook him. The article was written on the broad balcony of his house in Florida, close to the room where his wife was lying ill with fever, which at first was suspected to be yellow fever. During the anxious period of doubt he had given himself to reading all the medical literature at hand referring to yellow fever and plagues, and he gave the benefit of his information to the readers of the New York *Weekly Tribune*, from which we reprint the greater portion of his article. It will be seen from the reports which we give in another column that the loss of Mr. Proctor's valuable life was probably not due to yellow fever, but to the panic produced by the yellow fever scare, which caused the doctors attending him and the New York hotel proprietor to insist on his removal on a rainy and windy night when he was suffering from *Malarial Fever*.

PLAGUE AND PESTILENCE.

YELLOW FEVER, though not in reality a more destructive disease, even in the places where it is apt to prevail, than some others which are more familiar, is more suggestive of the idea of pestilence than any existent disease, and more strikingly recalls, when it appears in a fully developed form, as ten years ago in New Orleans and Memphis, the horrors of the ancient plagues. There is something in the insidious nature of its approach, its fell action in the worst cases, and the despair which seizes even from the beginning the larger number of its victims, which reminds us of what we have read respecting the plagues of Athens, of Florence, of London, in the days of old. I am told by those who witnessed the flight from Jacksonville, Florida, a short time since, when first the appearance of yellow fever in that town had been announced, that the behaviour of many of the refugees indicated absolutely panic terror, though, as it turned out, not one among the whole number had been infected by the disease, so that the risk individually run by that panic-stricken crowd while in the town from which they were flying must have been small.

It may be interesting to recall a few of the features of the great plagues and pestilences of history—if for no other reason, for this: that men may see how light even the worst infections of the kind during this century have been by comparison.

The account given by Thucydides of the plague of Athens,

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twenty-three centuries ago, suggests a scene of fearful horror. The origin of the plague is noteworthy in the light of modern theories and discoveries respecting disease germs. The Spartans, having overcome the Athenians in the field, ravaged Attica while nearly all its inhabitants were closely shut up within the walls of Athens. Whether the germs of the disease had already been conveyed to Athens, or whether spreading in the air they found in the overcrowded sorrow-stricken city a favourable field for their development, cannot be learned. It was said that the plague had had its origin in Ethiopia, the region now including Abyssinia, Nubia, and the Soudan, and had travelled thence by Egypt and Asia Minor to Athens. But its rapid development in Athens would certainly seem to suggest that this plague (and probably therefore others) depended on surrounding conditions for its development.

This pestilential fever began with heat in the head and inflammation in the eyes. The tongue and throat became bloody and the breath fetid. Sneezing and heavy coughing, hiccoughs and spasms, marked the progress of the disease. Colic and intense pain supervened. The skin became red, ulcers formed here and there; and although the internal fever was intense, the skin was cold. Thirst was unquenchable, and intense pain rendered sleep impossible. The fate of the patient was usually decided by or before the seventh day, death generally closing his sufferings between the seventh and the ninth day. Few survived, and for a large proportion of those who did life was worse than death, since either they were wholly crippled or the disease left them with mind impaired and memory gone. No remedy was found for the disease, and the helplessness of the physicians caused a despondency among those who were attacked which rendered the mortality largely greater than otherwise it would probably have been. But most of those attacked were left untended; for it was found that few among the attendants on the sick escaped, so that only those of bravest and most generous minds dared the risk of nursing even those dearest to them. It was impossible, crowded as the beleaguered city was, to keep the healthy apart from the sick. Hundreds flocked around each of the public fountains to allay their raging thirst. The temples were filled with corpses, for it was impossible to get the dead conveyed to suitable places of interment.

Whereas the assurance of death should produce in healthy minds the very reverse of the idea, "Let us eat and drink, for to-morrow we die"—whether the to-morrow be figurative or literal, in times of plague and pestilence, when all men feel the probable nearness of death, and, even where most confident, are reminded of its certainty at no very distant date, the majority invariably turn to riotous living. They seek to fill what remains to them of life with all the sensual pleasures they can crowd into it. Thus as in Athens during the time of horror so graphically described by Thucydides, riot and debauchery prevailed unceasingly. Gross dissipation and tumultuous revelry went on in such sort that but for the signs of death and disease everywhere prevalent, a stranger entering the city might have imagined that it was a time of wild rejoicing over some great national triumph. Men committed crimes from which at other times the fear of the law would have deterred them; for the law had no terrors where nature threatened an earlier punishment than any legal process could inflict. As they saw the good and the bad, the openly profane and the professedly pious, stricken down impartially, they lost all belief in the control of the gods, and therefore saw no reason to deny themselves whatever pleasures they could obtain.

Thucydides says that during the plague, there died within the limits of the city of Athens, then as now but a small city, no fewer than five thousand of the soldiers, and of the other inhabitants a number too great to be reckoned.

Very striking is the contrast between the plague of Athens, affecting chiefly a single city and lasting but a short time, and the plague which extended with varying degrees of intensity from Persia to Gaul in the reign of Justinian, lasting no less than thirty years, and destroying (according to an estimate which the historian Gibbon did not consider extravagant) no fewer than a hundred millions of human beings—a number not much less than the entire population of Great Britain and the United States.

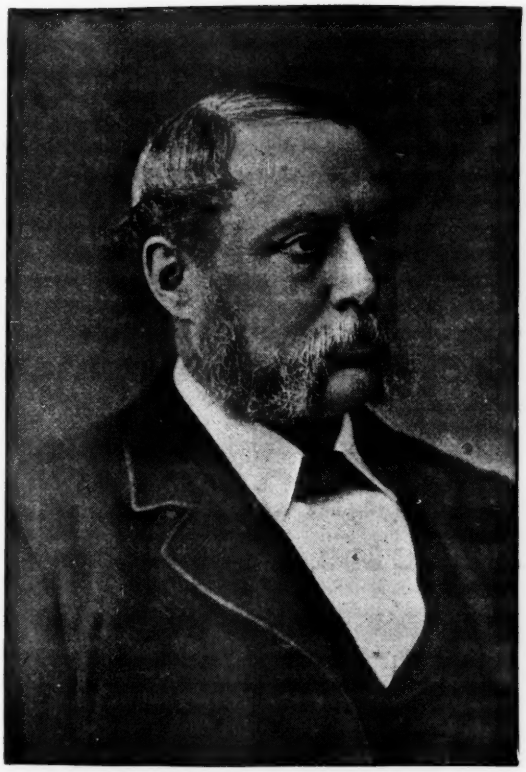
In this long-lasting and most terrible plague the features of the disease were quite unlike what had been noticed during the plague of Athens. Procopius studied it both as historian and physician. In most cases the mind was first attacked, anxious fears and saddening visions seeming to overpower the reasoning faculties. But usually a mild fever was the first sign of mischief, nothing in its earlier progress suggesting any serious danger. Before long, however, the glands beneath the ears, under the arm-pits, and in the groin swelled alarmingly, especially as these swellings were soon recognised as signs that the dreaded plague fever had indeed seized its victim. The swellings became tumours, within which a hard dark substance as large as a bean was formed. If these tumours remained hard and dry, blood poisoning followed, and on or about the fifth day from the setting in of the disease the patient died. But if the tumours softened and suppurated, the venom of the plague seemed to be discharged, and the patient was saved. Sometimes the fever accompanying the development of these tumours brought a profound lethargy on the patient, who suffered little, begging only to be let alone that he might die untortured by medicine, surgery, or even nursing. More frequently the fever brought on raging and delirium. In all cases the bodies of those who died of the plague were covered with black boils or carbuncles. All hope was given up when these appeared. Among those who recovered a considerable portion lost sight and hearing, while others remained ever afterwards speechless.

Strictly speaking the peculiarities above described are to be regarded as characteristic of the true plague—so that the so-called plague of Athens, as well as the plague which afflicted the whole Roman Empire in the reign of Aurelius, and that again of the third century, were not really plagues in the full sense of the term. It would almost seem, indeed, as though the plague of Athens was but an exceptionally malignant form of remittent fever.

The true plague is defined as a specific contagious fever accompanied by the formation of tumours, and sometimes of carbuncles. Dark spots on the skin are regarded as infallible signs of death. They are due to the effusion of blood under the skin, and precede death by only a few hours. The skin is sometimes so covered with these spots as to assume a dark livid hue after death—whence the name Black Death given to the worst form of plague.

During Justinian's plague, the idea prevailed that the disease was not contagious—an idea which if it saved the afflicted nations from a portion of the troubles accompanying the appearance of pestilence, brought in others more terrible. Doubtless the quiet disregard of danger at such seasons is desirable, so only that it does not cause the neglect of necessary precautions. But disregard of danger is a dangerous quality when it has its origin merely in ignorance. It so proved in this case. The friends and relatives of the deceased were more careful in their attentions than during most plagues, but the absence of all restraints on the communication of the disease from house to house, from city to city, and from country to country led to results the most disastrous. Procopius tells us that the

THE LATE R. A. PROCTOR.



RICHARD ANTHONY PROCTOR was born in Cheyne Row, Chelsea, on March 23, 1837. He was the youngest of four children, two sons and two daughters, and was rather a delicate child. From the first he was a great reader, devouring solid books such as Guizot's "Girondists," Lamartine's "Reformation," Alison's "History of Europe," before he was eleven years old. His mother seems to have been a clever woman, a native of Guernsey. As Richard was a feeble child, she kept him at home as long as possible, attending to his education herself. His father was a solicitor, with literary tastes: he died when his youngest son was thirteen years old. Richard Proctor was sent to King's College, London, and then to St. John's College, Cambridge, in company with his elder brother, William Proctor, who is now a clergyman. Both brothers then intended to enter the Church. During later boyhood Richard Proctor's health had greatly improved, and he became when at college decidedly athletic. He was captain of the Lady Somerset—a Johnian boating club—and brought his boat up several places on the river. During his second year at Cambridge he lost his mother, to whom he was devotedly attached; and shortly afterwards, while travelling with his sister, he fell in love with a young Irish lady, a Catholic, to whom he was privately married while at college. He came out in the Honours list of 1860 as twenty-third wrangler, a degree which greatly disappointed his friends, many of whom had already recognised his remarkable talent. He now commenced to look about him for a profession. He felt unable to fulfil his mother's wish, and enter the Church. For a little time he hesitated with regard to the law, and ate dinners at the Temple; but ultimately he decided to devote himself to astronomy. He lived for short periods first in Ayr, then in Edinburgh, then near Dublin, and afterwards in Devonport.

Mr. Proctor's first literary venture was an article on double stars, which he sent in 1865, without introduction of any kind, to the editor of the *Cornhill Magazine*. He was greatly pleased to find it accepted, and he afterwards used to tell how he was on the point of despatching a letter of warm thanks to the editor for two copies of the magazine containing the article which had been sent him, when a letter arrived enclosing a cheque in payment. His first book was on "Saturn and its System"; it was published in 1865, at his own expense, and occupied him four years in preparation. When it was published it was very favourably received by astronomers, who recognised that a new writer of exceptional ability had appeared. Geometrical conceptions were expounded with great clearness, and astronomical and historical details, which in other hands would have appeared tediously complicated, were explained with an ease and enthusiasm which attracted the reader. But though the book was well received by the reviewers, the public did not buy it, and he found, to his great disappointment, that its publication was a source of loss instead of profit. This came upon him at a time of great monetary anxiety, for he was a considerable shareholder in a colonial bank which failed during the commercial panic of 1866, entirely absorbing his capital. His family was increasing in number, and the grave question pressed upon him whether it was not his duty to forsake astronomy and devote himself to teaching, or seek an official appointment. He preferred the independent position of an author, and had a great idea of the importance of the calling. He, therefore, resolved upon another effort to make writing pay, and devoted himself to popular astronomical books and articles.

By 1872 he had so far restored his monetary position, by means of astronomical writing and lecturing, that he was able to allow himself to accept the unpaid post of secretary of the Royal Astronomical Society, which he held till November 1873, when he retired in order to go to America on a lecturing tour. During his secretaryship he superintended the publication of the largest volume of the *Monthly Notices* of the Society which had appeared up to that time or which has since been published. More than half of it was written by himself. It contains some of his most valuable articles on "Star Distribution," "The Construction of the Milky Way," "The Distribution of Nebulæ and Star Clusters," and on "The Proper Motion of Stars." These papers, which are illustrated by excellent maps, completely disposed of the artificial theories which had previously been in vogue with respect to the construction of the stellar universe. No doubt some advances had already been made on Sir William Herschel's "flat grindstone" hypothesis with respect to the form of the Milky Way, but Mr. Proctor's papers were the first which graphically showed the results which had been arrived at, and they materially extended the generalisations which may now be said to be universally accepted.

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Mr. Proctor was an adept at all that refers to the methods of projection and map-drawing. One of his greatest undertakings was the charting of the 324,000 stars contained in Argelander's Great Catalogue, showing the relation of stars down to the eleventh magnitude with the Milky Way and its subsidiary branches.

Mr. Proctor's energy was almost unbounded. He played with great expression on the piano, and found time for chess and whist, both of which games he played extremely well. He wrote on Luck and Chance, on the Geometry of Cycloids, and on Mental Phenomena. He was twice married, his first wife having died in 1879, leaving six children. He married again, on his return from a lecturing tour in Australia in 1881, a widow with two young children, so that at the time of his death he had a family of eight children dependent upon him. Notwithstanding his enormous industry it is sad to have to record that the financial results which will be realised by his representatives are proving anything but satisfactory. His many friends should now remember that the purchase of his books will prove a material benefit to his family. Readers of KNOWLEDGE will be glad to learn that the liberality of the purchasers of its copyright deserves full recognition from his family, who desire the fact to be recorded.

Mr. Proctor's last and most important work, "Old and New Astronomy," on which he had been occupied for some years—and to which he had given his best work—was not quite completed at his death, which happened on September 12, 1888. The book is, however, so far advanced that it will be finished by his friend Mr. Ranyard.

OLD AND NEW ASTRONOMY.

By RICHARD A. PROCTOR,

Author of the Articles on Astronomy in "The Encyclopædia Britannica" and in "The American Cyclopædia."

IN course of publication, a Treatise on Astronomy, to be completed in twelve monthly parts and a supplementary section. In each there will be sixty-four pages, imperial octavo (size of this page), many cuts, and two plates, or one large folding plate. Thus the complete volume will contain, with index, preface, &c., about 800 pages and abundant illustration. The price of each part will be 2s. 6d.; that of the supplementary section, containing tables, index, and preface, 1s. The price of the complete work, in cloth, 36s.

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plague spread from Persia to Gaul, from the sea-coast to the interior. No island or mountain district was so sequestered but that the plague spread to it, either at its first passage across a region, or later (sometimes with even more terrible effect) in places which were supposed to have escaped. The succession of the seasons seemed to have no influence on this long-lasting pestilence. (I have named thirty years, but, according to some historians, its effects continued for more than half a century.)

The plague of Florence in the middle of the fourteenth century was remarkable, like that of Athens, for the limited area which it affected, or rather in which it wrought its most deadly effects and rose to true plague pitch. If Florence when the plague reached her had given way to despair, and taken no measures to resist the enemy, one might more readily understand the terrible intensity of the sufferings of the people. But all remedies known in those days were tried. The streets were cleaned; suspected persons were removed or prevented from entering; every measure was adopted which the wisest and most prudent of the inhabitants could suggest. Yet the plague raged in Florence as it raged nowhere else.

Tumours such as those which appeared during Justinian's plague appeared during the plague of Florence, and as in the sixth century so in the fourteenth, purple spots on the body of the diseased were regarded as sure tokens of approaching dissolution. Death came earlier, however, the sufferers usually dying on the third day. Animals as well as men were infected. Boccaccio tells us that he saw two hogs rooting among the clothes of a man who had died of the plague—"in less than an hour," he adds, "they turned round and died on the spot."

As in former plagues, the restraints of religion seemed to lose their influence. Every one, says one writer, did as he pleased. This doubtless is an exaggeration, since we have evidence that the monks and friars stood bravely to the work of religious consolation and physical help. The idea conveyed in the introductory matter of Boccaccio's "Decameron," that the occasion seemed one when men and women seemed to turn naturally from the gloom around to festivity and dissipation, even to debauchery and riot, is undoubtedly correct. What could it matter? all save a few devotees seemed to think. "If we are to die by the plague, we may as well enjoy what little of life remains to us; if we are to survive, we need not trouble ourselves with unnecessary anxieties."

When the plague was at its highest towards its close, it became the custom for the dead to be put out of doors at night that the officers appointed for the purpose might remove them in the morning. It is computed that between seventy thousand and one hundred thousand died of the plague in Tuscany alone, between March and August 1348. "Such," says Boccaccio, "was the severity of heaven."

The plague in England, described by Defoe as an eye-witness, though he was but an infant in 1665 and 1666 when it raged, though terrible was not to be compared for severity with the plague of 1346. As many died, indeed, perhaps more; but in a much larger population. It began in the autumn of 1665; but the cold winter of 1665–1666 greatly checked its ravages, and many hoped that it would altogether disappear. But with the early spring of 1666 deaths from the pestilence began to be announced, until presently it began to be recognised that the real attack had begun. The symptoms were akin to those observed during the plague of Florence, but sometimes death came even more rapidly. In July 2,000 died weekly, but by September the weekly number of deaths from the plague had risen to 8,000. The dead were buried together in certain fields, then suburban, now within London proper. There is one triangular space (not built on) between Brompton and Kensington, where large numbers were buried. Many of the dead were buried in the fields at present occupied by the houses in Golden Square; and it was noticed that during the visitation of cholera in 1849 the disease seemed more malignant in that region; but whether this was due, as some surmised, to the opening of drains communicating with the trenches in which the plague-stricken were buried in 1665 and 1666 seems open to considerable question.

In the East the plague still appears from time to time, but whatever may be the reason, it seems unable to pass thence into Europe. During the plague of 1835 in Alexandria (in which 9,000 inhabitants of that city perished), twenty-five ships, eight of which were certainly infected with plague, carried 31,000 bales of cotton to England. Yet no case of plague occurred among those employed in unloading and disinfecting the cargoes. Equally large cargoes were unloaded at Marseilles and Trieste, with the same result. Thus the disease, however communicated, is apparently never conveyed by merchandise. It would seem, in fact, to require special infection, since in 1878, the plague was for two months confined to a single village in Russia. In 1834 plague existed for eight months in Alexandria before being communicated to Damietta and Mansoorah, though no measures were taken to interrupt traffic. On the other hand, where several plague-stricken persons are together in a house or ship, a certain atmosphere of infection seems to be formed by which the disease may be transmitted.

RICHARD A. PROCTOR.

MR. PROCTOR'S DEATH.

(Reprinted from the *Ocala Banner*.)

A MEETING of physicians, representing the Boards of Health of several of the interior counties, was held in Ocala last Sunday, and among the matters discussed was that of the death of Mr. Richard A. Proctor. Every physician present ridiculed the idea of his having died of yellow fever as reported by his attending physicians and the health authorities of New York city.

The opinion was unanimous that the symptoms given by the physicians attending him, as reported in the *World*, *Herald*, and other newspapers, from the time he left his home at Oaklawn until he was sent mercilessly forth in a drenching rain to his death, plainly and unmistakably pointed to the one conclusion that the disease of which the unfortunate astronomer died was *malarial hæmorrhagic*, and not *yellow fever*.

Dr. Thomas P. Gary, the President of the combined Boards of Health of the counties present, was appointed a committee to prepare for publication in the New York newspapers the opinions as stated above, and the facts upon which they were based, which Dr. Gary did in a brief space of time, and the same was forwarded at once to the New York newspapers for publication.

The facts in Mr. Proctor's case are mysterious. There has never been a case of fever in this county but one, and that was a stage-driver from Gainesville during the epidemic in 1871, and in that case the fever did not spread, the man himself recovered, and there was no alarm. People were not as panic-stricken in those days as they are now. Mr. Proctor's home, at the time of his leaving it, was fully a hundred miles from any infected district. For weeks previously he had been at home busily engaged in the prepara-

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tion of his great astronomical works, and had not come in contact with any person from any infected district before leaving for New York, and on his way thither he went seventy-five miles around to avoid the infected regions. It has been ascertained that there were ninety-three passengers on the train with him, and yet among this big list of passengers no other case was developed, nor has any since developed so far as known. That strikes even those unacquainted with the disease as somewhat remarkable, to say the least. But more than that, Mr. Proctor was reported sick and vomiting the first day of his journey, and any layman knows that that is not the first indication of yellow fever, and Dr. Gary, in his report, a copy of which we are sorry was not given us, makes this plain. Mr. Proctor, if he really came in contact with the disease, must have passed through an incubating season before the microbes would have made their presence known, and vomiting, instead of being the first is one of the last manifestations of the disease.

But granting that all the yellow fever symptoms had been plainly and unmistakably developed, there is no excuse nor palliation, say these doctors, and righteously, for his removal from his hotel after having remained there for two days and a half, and at midnight in a raging storm. The mischief, if any, had already been done.

It is no wonder therefore that his friends and neighbours, and every intelligent citizen of Florida should be shocked and indignant to hear of the barbarous and unprecedented cruelties to which he was so mercilessly subjected.

When Mr. Waterman was taken sick in Tampa at the beginning of this season, notwithstanding that city passed through an epidemic of the scourge the summer before, and is directly in the yellow fever zone, he was subjected to no such treatment as that visited upon Mr. Proctor, but on the contrary, Mr. Waterman was never removed from his hotel, which was located in the heart of the city. And if he had been, the enlightened and humane physicians of that city would not have forced him out in a torrent of wind and rain and in the middle of the night. If they had, public sentiment would have driven them from the city.

The "eminent doctors" who subjected Mr. Proctor to this inhuman treatment should follow Henry Guy Carlton's advice, published in our last issue from the New York *World*, and when another suspicious case of fever is developed in New York, consult some "old turbaned New Orleans mammy," with "wrapped and kinky hair," and be guided wholly by her counsels. She would not mistake a case of *malarial hæmorrhagic fever* for *yellow fever*, and in any event would not hurry so distinguished a victim forth in a storm at night to meet his certain and almost immediate death.

The statement of Professor Jacobi, "that yellow fever is in all parts of Florida, and that there is danger of persons from any section of the State spreading the disease," was also discussed by these doctors. They positively announced, after the most diligent and rigid investigations, that in only four of the forty-five counties of Florida has a single case of yellow fever made its appearance this summer.

THE FORMATION OF CORAL REEFS.

By W. H. Wesley.

THERE are perhaps few facts more striking to the imagination than the existence of the innumerable reefs and islands of coral which bestrew our tropical seas. At the same time there are few problems in physical geography more full of difficulties than those presented by these little rings of land —often only a few yards in width, and rising but a few feet above the swell of the mightiest oceans, to which they oppose a barrier, apparently so frail yet really so stable. The discussion with regard to their formation which has taken place during recent years, and of which it is proposed to give a brief *résumé*, shows that the problem is yet by no means solved.

The principal reef building species of coral are essentially shallow water forms, living between extreme low water-mark and a depth of twenty to thirty fathoms. They flourish especially where the surface temperature never sinks below 70° Fahrenheit, and where the annual range is not more than 12°. They require an abundant supply of fresh water, and are killed if sand or other sediment is deposited upon them. They cannot endure an exposure to the air for even a few hours.

Coral reefs have been divided into three classes, viz.:—

1. Fringing reefs, near a shore, from which they are separated by a narrow and shallow channel.

2. Barrier reefs, forming a more or less perfect ring round a central island, with a deeper and wider "lagoon" channel.

3. Atolls, or rings of reef without any central island. The smaller atolls are generally perfect rings, and in many of them the lagoon has been filled up, while the larger atolls have mostly open channels into the lagoon. They are sometimes mere rings of separate islets, and there are cases in which the islets forming the rim are themselves smaller atolls. The rim seldom exceeds a mile in width, and is mostly much less.

Many atolls and other reefs are always submerged, and others are only uncovered at extreme low tide. The seaward face of barrier reefs and atolls is generally very steep and the depth outside very great, while the lagoon is comparatively shallow. In some of the larger atolls, however, the lagoon is in parts as deep as 40 fathoms.

In all coral reefs it is only the extreme outer margin that is composed of living coral. The mass of the reef below water is formed of densely compacted coral, resembling ordinary limestone; but the portion above the water which (except in cases of upheaval) must have been formed by wave action alone is more porous in structure. Masses of coral, detached from the outer face, are piled on the top, forming a rampart, which becomes consolidated by the deposit of finer particles and of carbonate of lime held in solution by the water, while the living coral on the exterior face preserves the land from destruction. The rampart of coral boulders and blown coral sand is usually the highest portion of an atoll, the land sloping gradually towards the lagoon.

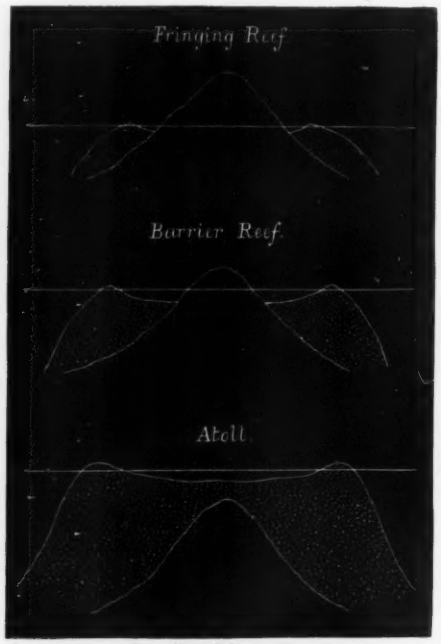
After the reef is thus raised above the sea-level there is a gradual accumulation of soil, in great part from the pumice stone from submarine volcanoes. The pumice being piled on the reef by the waves, in time disintegrates and forms a red clayey soil, which becomes deeper towards the lagoon shore, where the most luxuriant vegetation is found.

We will now consider some of the explanations of coral formations which have been given. Long ago Chamisso suggested that an atoll owes its form to the growth of coral round the margin, the deposit of débris from the outside checking growth in the interior. To account for the depth of water outside the reef—far too great for the reef building corals—it was suggested that the growths commenced round the summits of submerged volcanic cones. But it was considered improbable by Darwin that such cones could exist in sufficient numbers, and after an extended study of many islands in the Pacific and other oceans, he arrived at the following conclusions:—

Coral formations lie in a region of *subsidence*. The corals commenced to grow round the sloping shore of an island,

Bird's-eye View of Caroline Island.

and the growth, rising upwards, reached the surface and formed a fringing reef. The land subsiding, the coral continued its upward growth, so that the central island was reduced in size, the intervening channel deepened, and a barrier reef formed, which by continued subsidence became an atoll, inclosing a lagoon, without an island. The following diagram will make this clear.



In the case of submerged reefs, Darwin assumed that the subsidence had been so rapid that the coral had been carried into deep water and killed, before it had time to extend its growth in an upward direction.

Darwin's theory of subsidence was arrived at after an exhaustive study of the facts at his disposal; it was supported by a mass of evidence, and put before the world with admirable clearness and force. It was at the same time so simple and satisfactory, explaining at the same time the various forms of reefs and the great depth of water surrounding them, that it is not surprising that it met with general acceptance. But beautifully simple and complete as the theory is, it presents some serious difficulties. First among these, it involves the assumption that the whole Central Pacific, besides other large areas, has undergone enormous subsidence. Darwin, of course, fully recognised this—indeed, he was led to the belief that a Pacific continent had been submerged so completely that only a few of its mountain summits appear above the surface. But most recent deep-sea researches seem to prove the great antiquity and permanence of the large ocean basins, and this evidence must all be put aside if the Darwinian theory is to be accepted in its entirety.

Besides this general objection to the subsidence theory, many instances have been brought forward of undoubted *elevation* of the land in coral regions. Rein has shown that the Bermuda reefs have undergone elevation. Alex. Agassiz mentions* other elevated reefs in the West Indies, and with regard to Florida he says:—"All naturalists who have visited the reefs have felt the difficulty of applying Darwin's theory to the peculiar conditions existing along the straits." Semper in the Pelew Islands experienced the same difficulty, owing to the clear evidence of upheaval, and Dr. H. B. Guppy says of the Solomon Islands*:—"These upraised reef masses, whether atoll, barrier reef, or fringing reef, were formed in a region of elevation. Mr. Darwin's theory, which ascribes atolls and barrier reefs to a movement of subsidence, cannot be applied to the islands of the Solomon group." More recently it has been shown by Mr. G. C. Bourne† that there is evidence of upheaval in some of the atolls of the Chagos group in the Indian Ocean.

Professor J. D. Dana, in his elaborate review of the whole question,‡ considers some of these instances of elevation, but does not think they conflict with Darwin's theory, which, while insisting upon a general subsidence, would admit of partial and local elevations.

Again, it is a difficulty on the theory that fringing reefs, barrier reefs, and atolls are merely different stages of the same formation, that all three kinds not unfrequently occur in close proximity, as in the Fiji Islands. On the hypothesis of general and very extensive submergence, we should expect that all the formations in a given area would be reduced more or less to the same condition, as in the Indian Ocean, where only atolls occur.

Besides this, all oceanic islands (other than coral islands), with scarcely an exception, are of volcanic origin, and volcanic regions are generally areas of elevation rather than of depression.

Moreover, Dr. Guppy found in the Solomon Islands the upraised reefs to be of moderate thickness only—their vertical measurement not exceeding the usual limit of the reef-building zone—while, according to Darwin's view, the vertical thickness of a barrier reef or atoll should be enormous.

But if it is shown that Darwin's theory is at any rate not of universal application, what other view can be adopted? One of the most complete alternative theories was brought forward § about eight years ago by Mr. John Murray, one of the naturalists of the *Challenger* expedition. He thus summarises his views: (1) "When coral plantations build upon submarine banks, they assume an atoll form, owing to the more abundant supply of food to the outer margins, and the removal of dead coral rock from the interior portions by currents and by the action of the carbonic acid dissolved in sea water. (2) That barrier reefs have been built out from the shore on a foundation of volcanic débris, or a talus of coral blocks, coral sediment, or pelagic shells, and the lagoon channel is formed in the same way as a lagoon."

Mr. Murray also called attention to the immense number of other organisms (calcareous algæ, foraminifera, pteropods, &c.) existing in tropical seas, which secrete carbonate of lime, and whose remains are found in great abundance on submarine banks, where they accumulate too rapidly for the sea water to have much effect in dissolving them. These deposits form banks upon which flourish numerous species of foraminifera, sponges, deep-sea corals, &c., and thus rise to a level at which reef building corals can live. Alexander Agassiz has also described the great submarine banks in the Gulf of Mexico, largely composed of the remains of minute marine organisms, the form and direction of the banks being determined by the prevailing winds and currents.

Mr. Murray shows that submarine volcanoes have been found to be far more numerous than was supposed by

* "Mem. American Acad.," vol. xi.

* "The Solomon Islands." London: 1887.
† "Proc Roy. Soc.," vol. xliii.
‡ "American Journal of Science." Third series, Vol. xxx.
§ "Proc. Roy. Soc. Edin." Vol. x.

Darwin, so that the older view that corals built upon these cones was reasonable and probable. The cone, if rising above the surface, would soon be reduced by the action of the waves to a suitable level, or if too low, might be raised by organic deposits. Upon this the true reef-forming corals would commence to build. The outer surface being always in the most favourable position with regard to food supply, the edge would tend to reach the surface first.

Mr. Murray lays great stress upon the power of the sea-water (always containing carbonic acid, especially at great depths) in dissolving the coral which has ceased to grow, and to this cause he attributes the deepening of the central lagoon in an atoll, and the lagoon channel in a barrier reef. "Thus growing seawards on its outer face, and dissolving away in the lagoon, the whole expands after the manner of a fairy-ring, and the ribbon or reef of land can never in consequence increase beyond half or three-quarters of a mile in width" ("Journal of the Royal Institution," 1888). The greater extent of coast line in a small atoll, as compared with its contained lagoon, is probably the reason why the latter has been frequently filled up, fragments torn from the outside being carried over the rim by waves, and piled in the interior.

The power of sea-water to dissolve coral structures has been investigated, and proved by laboratory experiments, but it is still a question whether the action upon small detached pieces can be compared with that which would take place with the massive coral limestone of the reefs. There is also evidently a difficulty in understanding, as Mr. Darwin justly observes in a letter dated September 1880, and published in "Nature," November 17, 1887, how "there should be rapid dissolution of carbonate of lime at great depths [where few calcareous remains are found] and near the surface [in the deepening of lagoons] but not at intermediate depths where he [Mr. Murray] places his mountain peaks." Captain Wharton† has given several instances of entirely submerged atolls in the China seas in which the height of the rim above the lagoon is quite as great as in atolls which have reached the surface.

Murray's views with regard to the volcanic foundation of coral reefs are strongly supported by Dr. Guppy's observations.* He observes: "These upraised reef masses in the majority of the islands rest on a partially consolidated deposit, which possesses the characters of the volcanic muds that were found during the *Challenger* expedition to be at present forming around volcanic islands." Dr. Guppy infers that the deposit envelops anciently submerged volcanic peaks.

Mr. Bourne, in his interesting account of the atoll of Diego Garcia (which has a channel leading into the lagoon) in the Indian Ocean, previously quoted, shows that the reef is being worn away by tidal scour *on its lagoon side*, while the exterior is protected by the growing coral. Within the lagoon the corals only exist in patches, their growth being checked by the deposit of sediment. The Diego Garcia observations strongly support the view that coral growth proceeds most rapidly in a *horizontal* rather than in a vertical direction, as required by Darwin's theory.

Perhaps in the present state of our knowledge it will be wisest, as Dr. Guppy has suggested,† to regard as possible all the various agencies which have been suggested as producing the various forms of reef. Outside there are the directing influence of currents, the increased food supply, and the action of the breakers. Within the lagoon are the repressive influences of sediment, the boring of the numerous organisms that find a home on every reef, the solvent influence of carbonic acid, and the tidal scour. In some places also it is possible that subsidence may have played its part.

The bird's-eye view of Caroline Island has been copied from an excellent plate given in Professor Holden's Report of the 1883 Eclipse Expedition.

[We have been disappointed at the last moment in the receipt of two other woodcuts which were expected to illustrate this article.—ED.]

* "The Solomon Islands."

† "Nature," vol. xxxvii.

HENRY DRAPER MEMORIAL.

DR. HENRY DRAPER, of New York, who was the first to photograph a nebula, succeeded in 1872 in obtaining several photographs of the spectra of stars. His father — nearly thirty years previously — had obtained the first photograph of a human being, as well as the first photograph of the dark lines in the solar spectrum, both of these earlier photographs being taken on silver plates. At the time of Dr. Henry Draper's death in 1882, he was proposing to devote himself for several years to the photography of stellar spectra, making a catalogue of the spectra of all stars which could be photographed with the means at his disposal. His widow has raised a most suitable memorial to his memory, and that of his father, by providing funds for the establishment of a new department of Harvard College Observatory, where, under the superintendence of Professor E. C. Pickering—and with the aid of the 15-inch refractor and the 28-inch reflector used by Dr. Henry Draper, and other instruments which have since been devised by Professor Pickering—a spectroscopic catalogue of the heavens is being made, and photographs of the spectra of the brighter stars are being taken on a scale commensurate with the photographs of the solar spectrum taken only a few years ago.

Such large-scale photographs of the spectra of stars open out great possibilities in the near future of astronomy, for they will enable us to measure the velocities of stars in the line of sight (to or from the observer) with a much less percentage of error than the distances of the stars can be determined from measures of parallax. The apparent proper motion of stars (which can be determined very accurately from measures of their positions taken at intervals of many years) gives a guide to their velocities in directions at right angles to the line of sight, and with the motion in the line of sight accurately known, we shall be able to form a much juster notion of stellar distances and stellar motions than has hitherto been attained to.

THE EFFECTS OF COMPETITIVE EXAMINATIONS.

PROFESSOR DE MORGAN, who was certainly a most successful teacher if we estimate success by the number of distinguished mathematicians who were educated under him, delivered an introductory lecture, some forty years ago, on the evil effects of competitive examination, in which he stated that he considered such examinations to be among the crudities of an imperfect system, and to be as ineffectual in gaining the end either of *making* the best scholar or *showing* the best scholar, as its moral tendency is bad. The lecture was printed at the

request of some of his old pupils, and circulated amongst a good many of the thinking men of the day.

Professor Baden Powell wrote, thanking De Morgan for his lecture, and added: "I wish it could be more widely circulated among our candidates at Oxford and Cambridge. Perhaps there was something in this respect better in the system of our ancestors' disputations, in lieu of examinations. I have often wished that there was something like making a man read a dissertation on a subject of his own choosing, and then cross-examining him on his own arguments. Many would be plucked for not understanding their own meaning." Sir John Herschel wrote, "I was greatly delighted with your protest against the cramming system in your opening lecture," and Dr. Whewell wrote that he was anxious that some experiment should be made as to the possibility of getting rid of such examinations.

De Morgan did not object to examinations which were not competitive; for example, he felt that examinations by teachers to test the amount of knowledge really gained were very useful to guide them in their efforts to direct the thoughts of their pupils and interest them in the subjects taught. He believed that the most effective education commences when the pupil begins to teach himself; when he is drawn onward by interest in the subject to think for himself rather than driven by the desire for approval or money reward to store his memory with facts or words.

Since De Morgan's day we have been drifting continuously in the direction of selection by competitive examination. Large sums of public money are now distributed according to the verdict of examiners, so that school managers and schoolmasters are induced to look at the children of the poorer classes as instruments for earning Government money, and boys in the richer and middle classes are pressed, frequently to the injury of their health, to store away material likely to enable them to answer questions which may be set by examiners. The fierce goad of emulation is applied frequently before the strength and development of the boy warrants it, to urge him to reproduce rapidly the thoughts of others, in order that he may be educated at the expense of the public or of some one else than his parents.

De Morgan thought that with those young men who struggle to be highest, and who suffer in the struggle, no stimulus is needed beyond their own pleasure in learning, and that if a teacher cannot make them feel this pleasure, he does not deserve the name of teacher. Educators have to learn that the aim of education is to develop power, and not to cram knowledge, and also that the mental and moral faculties come into activity at very different times in different individuals and types. The system of selection for Government employment by competitive examination probably handicaps the Saxon as compared with Jews and other Orientals who come to maturity at an earlier period in their life history; but I will not dwell on this probability, as it is doubtful whether, with the exception of generals and heads of departments, it is for the advantage of a community that the best individuals should be taken by the Government from private callings where they are likely to have more influence upon the action and thought of the public than they would have if trammelled by official usages, and induced to rest on their oars by the knowledge that they have an assured position and a pension to fall back upon in old age.

It has frequently been said that the Duke of Wellington would, by reason of his bad spelling, never have succeeded under the modern system in entering either Woolwich or Sandhurst; but, be this as it may, it is certain that the present system of examination is not suited to select youths who possess many important qualities which are likely to prove useful in the battle of life, such as judgment, truthfulness, good moral feeling; and it would be difficult to contrive a method by which these qualities could be selected in the examination-room. But where it is necessary to select, a better choice than competitive examinations afford would probably be made if a period of probation were required, and the selecting officers had an opportunity of watching the candidate while attempting the class of work at which he would be afterwards employed.

The most serious evils brought about by the system of competitive examination are those which affect the methods of thought of teachers and of the pupils subjected to examination. What will pay in the examination-room becomes the first question, and any intellectual interests which would lead to inquiry or separate investigation are treated as luxuries which must be sternly swept on one side. This has a tendency to repress the teacher who will teach best those parts of a subject which he most enjoys, or with respect to which he has made any original investigation, or has some original thought, perhaps quite unsuited for reproduction in the examination-room; but these must be suppressed, for to follow the text-book and to reproduce statements received on authority is the habit of mind which is rewarded with success. His pupils become apt parrots. He dare not teach them to think for themselves, or they might be beaten in the race. He does not dare to introduce them to the scientific methods of inquiry by which independent advance is made. They learn to store up ideas, but not to digest them; and the habit is acquired, which will cling to them through life, of reproducing the ideas of others uncriticised and unassimilated.

It is an axiom of physiologists that the over-development of one organ tends to the atrophy of others. If the memory is forced, the powers of reasoning and imagination will be stunted. The fact that calculating boys usually lose their exceptional powers—as their general education progresses—seems to show that atrophy may almost obliterate even strongly marked faculties. But with the present system of classification by examination and the great prizes offered to the successful, it is only to be expected that boys and young men will train for them regardless of other considerations, developing the memory at the expense of all other faculties.

A. C. Ranyard.

ON SOME STRANGE FEATS OF CALCULATING BOYS.

MY object in the present essay is to consider certain mental feats which seem calculated to throw light on that wonderful organ on which our consciousness, in the widest acceptation of the term, depends. In particular, they seem to indicate cerebral capabilities, uncommon at present, but which may one day be possessed by many. I do not deal here with the question, interesting though it is, whether hereafter the human race may possess greater mental energy than at present, but simply to discuss, and if possible explain, certain remarkable mental feats. I may, however, remark on this point that we must not be misled by the consideration that we do not recognise, in the few past centuries over which our survey extends, a law of continuous mental development, illustrated by the increasing greatness of the great men of successive ages. In the first place, if the average of intellectual development is steadily increasing, the men of exceptional mental power must appear to stand less conspicuously above that higher level than the great men of former ages above the lower average of their day. And,

again, the periods with which we have to deal are probably short compared with those which may be expected (when the laws of mental development come to be understood) to separate the appearance of exceptionally great minds. We carry back our thoughts to the last of the great ones in each department of mental action: and even if we do not exaggerate his relative elevation above his contemporaries, as we are apt to do, or overlook (as we are equally apt to do) the elevation of the great minds of our own time, we still forget that, in the steady rising of the mighty tide of mental progress, the waves successively flowing in above the tide-line may be separated in time by intervals of many generations, and a greater wave may be followed by several lesser ones, before another like itself, but riding on a higher sea, flows higher still above the shore-line which separates the unknown from the known.

We may begin conveniently by considering some illustrations of exceptional power in the form of mental activity least likely to deceive us—aptitude in dealing with numbers. It is well remarked by Dr. Carpenter, that this quality is so completely a product of culture that we can trace pretty clearly the history of its development. "The definite ideas which we now form of *numbers*," he proceeds, "and of the *relations of numbers*, are the products of intellectual operations based on experience. There are savages at the present time who cannot count beyond five; and even among races that have attained to a considerable proficiency in the arts of life, the range of numerical power seems extremely low. . . . The science of Arithmetic, as at present existing, may be regarded as the accumulated *product* of the intellectual ability of successive generations, each generation building up some addition to the knowledge which it has received from its predecessor. But it can scarcely be questioned by any observant person that an *aptitude* for the apprehension of numerical ideas has come to be embodied in the congenital constitution of races which have long cultivated this branch of knowledge; so that it is far easier to teach arithmetic to the child of an educated stock than it would be to a young Yanco of the Amazons, who, according to La Condamine, can count no higher than *three*, his name for which is Poettarrarorincoaroac."

As an illustration of congenital aptitude for dealing with numbers, Dr. Carpenter takes the case of Zerah Colburn: and in this I shall follow him, though, as will presently appear, I differ from him as to the significance of that case, the true interpretation of which I believe to be far simpler, but to promise much less, than that adopted by Francis Baily and quoted with approval by Carpenter.

Let us first consider the facts of this remarkable case—

Zerah Colburn was the son of an American peasant or small farmer. When he was not yet six years of age, he surprised his father by his readiness in multiplying numbers and solving other simple arithmetical problems. He was brought to London in 1812, when only eight years old, and his powers were tested by Francis Baily and other skilful mathematicians. From Carpenter's synopsis of the experiments thus made the following account is taken, technical expressions being as far as possible eliminated (or not used until explained):—

He would multiply any number less than 10 into itself successively nine times, giving the results (by actual multiplication, not from memory) faster than the person appointed to record them could set them down. He multiplied 8 into itself fifteen times, or, in technical terms, raised it to the sixteenth power; and the result, consisting of fifteen digits, was right in every figure. He raised some numbers of two figures as high as the eighth power, but found a difficulty in proceeding when the result contained a great number of figures.

So far there is nothing which cannot be explained (or which could not, if other facts did not render the explanation invalid) by assuming that the child possessed simply the power of multiplying mentally, with extreme rapidity and correctness, but in the ordinary way.* But the next test removes at once all possibility of explaining his work as done in the ordinary manner. He was asked what number, multiplied by itself, gave 106,929, and he answered 327, *before the original number could be written down.* This was wonderful. But he next achieved a more wonderful feat still, judging his work by the usual rules. He was asked what number, multiplied twice into itself, gave 268,336,125—in other words, to find the cube root of that array of digits; *with equal facility and promptness* he replied 645. Now, anyone acquainted with the process for finding the cube root—even the most convenient form of the process, as presented by Colenso and others—knows that the cube root of a number of nine digits could not be correctly determined, with pen and paper, in less than three or four minutes, if so soon. If the computor had so perfect a power of calculating mentally that he could proceed as safely as though writing down every step, and as rapidly with each line as Colburn himself in the simple processes before described, he would yet need half a minute at least to get the correct result. This, too, would imply such a power of mentally picturing sets of figures that, even if it explained Colburn's work, it would still be altogether marvellous, if not utterly inexplicable. We know, however, that Colburn was not following ordinary rules, but a method peculiar to himself. In point of fact, he was so entirely ignorant of the usual modes of procedure, that he could not perform on paper a simple sum in multiplication or division.

Let us proceed to further instances of his remarkable power of calculation.

On being asked how many minutes there are in forty-eight years, he answered, before the question could be written down, 25,228,800; which is correct, if the extra days for leap years are left out of account. He immediately after gave the correct number of seconds.

We come next, however, to results which appear much more surprising to the mathematician than any of the above, because they relate to questions for which mathematicians have not been able to provide any systematic method of procedure whatever. He was asked to name two numbers which, multiplied together, would give the number 247,483, and he immediately named 941 and 263, which are the only two numbers satisfying the condition. The same problem being set with respect to the number 171,395, he named the following pairs of numbers: 5 and 34,279; 7 and 24,485; 59 and 2,905; 83 and 2,065; 35 and 4,897; 295 and 581; and, lastly, 413 and 415. (I presume, as Mr. Baily gives the pairs in this order, that they were so announced by Colburn. The point is of some importance in considering the explanation of the boy's mental procedure.) The next feat was a wonderful one. He was asked to name a number which will divide 36,083 exactly, and he immediately replied that there is no such number; in other words, he recognised this number as what is called a *prime* number, or a number only divisible by itself and by unity, just as readily and quickly as most people would recognise 17, 19, or 23 as such a number, and a great deal more quickly than probably nine persons out of ten would recognise 53 or 59 as such.

* The account does not say whether he gave the figures successively from right to left or from left to right. If he began at the left, ordinary multiplication would not explain his success; for no one, however skilful, could multiply a number of thirteen or fourteen figures by a number of one figure so rapidly as to begin at once to name the left-hand digits.

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Now, if a mathematician were set such a problem, he would have no other resource than to deal with it by direct trial. Of course he would not try every number from 1 upwards to 36,083. He would know that, if the number can be divided at all, it must be divisible by a number less than 190; for any greater divisor would go, exactly, some smaller number of times into 36,083; and that smaller number would itself be a divisor. He would see that the number is not even, and therefore cannot be divided by 2, 4, 6, or any even number. The number is not divisible by 3; for, according to a well-known rule, if it were, the sum of its digits would be so divisible; therefore he would dismiss 3, 9, 15, and all numbers divisible by 3 not already dismissed. So with 5 (for the number does not end with a 5); so with 7, by trial: 11, 13, 17, and so on. But he would have to try many numbers of two and three figures by actual division before he had completed his proof that 36,083 has no divisors. Probably (for I must confess I have not tried) he would require about a quarter of an hour of calculation before he could be confident that 36,083 is a prime number. Here however was a child, eight years old, who, to all appearance, completed the work immediately the number was proposed!

The next feat was of the same nature, but very much more difficult; indeed, it taxed the young calculator's powers more than any other feat he accomplished. Fermat, a mathematician who gave great attention to the theory of numbers, had been led, by reasoning which need not here be considered, to the conclusion that if the number 2 be multiplied into itself 31 times (that is, raised to the thirty-second power), and 1 added, the result will be a prime number. The resulting number is 4,294,967,297. The celebrated mathematician Euler succeeded, however, after a great deal of labour (and, if the truth must be told, after a great waste of time), in showing that this number is divisible by 641. The number was submitted to Zerah Colburn, who was of course not informed of Euler's prior dealings with the problem, and, *after the lapse of some weeks*, the child-calculator discovered the result which the veteran Swiss mathematician had achieved with much greater labour.

Before proceeding to inquire how Colburn achieved these wonders, we must consider what was learned about his processes. He was not very communicative—doubtless because the faculty he possessed was not accompanied by commensurate clearness of ideas in other matters. In fact, we might as reasonably expect to find a child of eight years competent to explain processes of calculating, however easily effected, as to find him able to explain how he breathed or spoke. One answer which he made to a mathematician who pressed him more than others to describe his method was clever, though the mathematician was certainly not to be ridiculed for trying to get the true explanation of Colburn's seemingly mysterious powers—"God," said the child, "put these things into my head, and I cannot put them into yours."

Some things, however, he explained as far as he could. He did not seem able to multiply together at once two numbers which *both* contained many figures. He would decompose one or other into its factors, and work with these separately. For instance, being asked to multiply 4,395 by itself, he treated 4,395 as the product of 293 and 15, first multiplying 293 by itself, and then multiplying the product twice by 15. On being asked to multiply 999,999 by itself, he treated it, in like manner, as the product of 37,037 and 27, getting the correct result. In this case probably a mathematician would have got the start of him, by treating 999,999 as a million less one, whence, by a well-known rule, its square is a million millions and one, less two millions, or 999,998,000,001. "On being interrogated," proceeds the account, "as to the method by which he obtained these results, the boy constantly declared that he did not know *how* the answers came into his mind. In the act of multiplying two numbers together, and in the raising of powers, it was evident (alike from the facts just stated and from the motion of his lips) that *some* operation was going forward in his mind, yet the operation could not, from the readiness with which the answers were furnished, have been at all allied to the usual modes of procedure."

Baily, after discussing the remarkable feats of Zerah Colburn, expressed the opinion that they indicate the existence of properties of numbers, as yet undiscovered, somewhat analogous to those on which the system of logarithms is based. "And if," says Carpenter (quoting Baily), "as Zerah grew older, he had become able to make known to others the methods by which his results were obtained, a real advance in knowledge might have been looked for. But it seems to have been the case with him, as with George Bidder and other 'calculating boys,' that with the *general* culture of the mind this *special* power faded away."

With all respect for a mathematician so competent to judge on such matters as Francis Baily, I must say his explanation seems to me altogether insufficient. So far from the properties of logarithms illustrating the feats of Zerah Colburn, they illustrate the power of mathematical development in precisely the opposite direction. The system of logarithms enabled the calculator to obtain results more quickly than of old, *not* by the *more* active exercise of his own powers of calculation, but by employing results accumulated by the labours of others. Its great advantage, and the quality which causes every mathematician to be grateful to the memory of Napier of Merchiston, resides in the fact that, by taking advantage of a well-known property of numbers, tables of moderate dimensions serve a great number of purposes which by any ordinary plan of tabulation would require several volumes of great size. If it were possible for a calculator to use as readily a set of tables equal in bulk to five volumes of the "London Directory" as he now uses a book of logarithms, and if such volumes could be as easily and as cheaply produced, tables much more labour-saving than the books of logarithms could be constructed. But of course such sets of volumes would be practically useless if they could be produced, and it would be impossible either to find calculators to form the tables or printers and publishers to bring them out. Now, of all processes by which mathematical calculation can be carried out, no two can be more unlike than mental arithmetic on the one hand, and the use of tables, of whatever kind, on the other. Napier invented his system to reduce as far as possible the mental effort in calculation, making the calculator employ results collected by others; young Colburn's success depended on mental readiness, and he was so far from using the results obtained by others, that he did not even know the ordinary methods of arithmetic. A man of Napier's way of thinking would be the last to trust to mental calculation; whereas, if Colburn had retained his skill until he had acquired power to explain his method, he would have been the last to think of such a help to calculation as a table of logarithms. Napier strongly urged the advantage of aids to calculation; Colburn would scarcely have been able to imagine their necessity.

Nor is it at all likely—we could even say it is not possible—that properties of numbers exist through the knowledge of which what Colburn did could be commonly done. The mathematicians who have dealt with theory of numbers have been too numerous and too skilful, and have worked too diligently in their field of research, to overlook such properties, if they existed. Besides, it is scarcely reason-

able to suppose that a child who had but lately learned the nature of numbers, and was altogether unacquainted with the ordinary properties, should have intuitively recognised abstruser properties. A more natural explanation must surely exist, if we consider the matter attentively.

It happens that I am able, from my own experience, to advance an explanation which accords well with the facts, and especially with the circumstance that calculating boys usually lose their exceptional power of rapid reckoning when they are instructed in and taught to practise the ordinary methods; for I used formerly to possess, though in a slight degree only, a power of finding divisors, products, and so on, which—*unlike ordinary skill in calculation*—required only to be expanded to effect what Colburn effected. It was, in point of fact, simply the power of picturing a number (not the written number, but so many "things"), and changes in the number, corresponding to division or multiplication as the case might be. Thus the number 24 would be presented as two columns of dots each containing ten, and one column containing four on the right of the columns of ten. If this number were to be multiplied by three, all that was necessary was to picture three sets of dots like that just described; then to conceive the imperfect columns brought together on the right, giving six columns of ten and three columns each of four dots; and these three gave at once (by heaping them up properly) another column of ten with two over: in all seven columns of ten and one column of two—that is, seventy-two. This takes long in writing, but, as pictured in the mind's eye, the three sets representing 24 formed themselves into the single set representing 72 in the twinkling of an eye (if the mind's eye can be imagined twinkling). The process for division was not exactly the reverse of that for multiplication. Thus, 72 being pictured as seven columns of ten and one of two, to divide it by 3, the first six columns of ten were pictured as giving twenty sets of three horizontal dots; the next column of ten gave three vertical triplets, counted from the top; and then the remaining dot at the bottom, with the other two in the imperfect column gave another triplet, or twenty-four triplets in all. These triplets could all be *seen* as it were; and the only mental calculation, properly so called, consisted in counting them, which of course was easy, twenty of them being as it were already numbered.

R. A. PROCTOR.

(*To be continued.*)

DANGER FROM LIGHTNING.

THERE are persons not otherwise wanting in courage who experience an oppressive sense of terror when electrical phenomena are in progress. The Emperor Augustus used to suffer the most distressing emotions during a thunderstorm, and he was in the habit of retiring to a low vaulted chamber underground, under the mistaken notion that lightning never penetrates far below the earth's surface. Major Vokes, the Irish police officer—a man whose daring was proverbial—used to be prostrated by terror during a thunderstorm. We cannot doubt that, in these instances, nervous effects are produced which are wholly distinct from the fear engendered by the simple consciousness of danger.

We have said that the danger is small when a thunderstorm is in progress. If we consider the number of persons exposed during a year, in England, to the effects of lightning-storms raging in their immediate neighbourhood, and compare with that number the small number of recorded deaths, we shall see that the *probability* of being struck by lightning is very small indeed. The danger we are exposed to in travelling along the most carefully regulated railway is many times greater than that to which, under ordinary circumstances, we are exposed when a thunderstorm is raging around us. Yet, in cases of this sort, men do not reason according to the doctrine of chances—nor, indeed, is it desirable that they should. There are measures of precaution which, small though the danger may be, it is well to adopt. In a railway carriage, it would be foolish to let the mind dwell upon the danger to which we are in reality exposed, since we can do nothing towards diminishing it. But it would be as unreasonable to neglect precautions in the presence of a heavy thunderstorm, merely because the danger of being struck is small, as it would be to neglect the rules which regulate powder-stores, merely because the instances in which fires have been caused by carrying cigar-lights in the coat-pocket, or by wearing iron on the sole of the boot, are few and far between.

We have mentioned one precautionary measure adopted by the ancients. The notion that lightning does not penetrate the earth to any considerable depth was in ancient times a widespread one. It is still prevalent in China and Japan. The emperors of Japan, according to Kæmpfer, retire during thunderstorms into a grotto, over which a cistern of water has been placed. The water may be designed to extinguish fire produced by the lightning; but more probably it is intended as an additional protection from electrical effects. Water is so excellent a conductor of electricity that, under certain circumstances, a sheet of water affords almost complete protection to whatever may be below; but this does not prevent fish from being killed by lightning, as Arago has pointed out. In the year 1670, lightning fell on the lake of Zirknitz, and killed all the fish in it, so that the inhabitants of the neighbourhood were enabled to fill twenty-eight carts with the dead fish found floating on the surface of the lake. That mere depth is no protection is well shown by the fact of those singular vitreous tubes called fulgurites, which are known to be caused by the action of lightning, often penetrating the ground to a depth of 30 or 40 feet. And instances have been known in which lightning has ascended from the ground to the storm-cloud, instead of following the reverse course. From what depth these ascending lightnings spring it is impossible to say.

Still, we can scarcely doubt that a place underground, or near the ground, is somewhat safer than a place several storeys above the ground floor.

Another remarkable opinion of the ancients was the belief that the skins of seals or of snakes afford protection against lightning. The Emperor Augustus, before mentioned, used to wear seal-skin dresses, under the impression that he derived safety from them. Seal-skin tents were also used by the Romans as a refuge for timid persons during severe thunderstorms. In the Cevennes, Arago tells us, the shepherds are still in the habit of collecting the cast-off skins of snakes. They twist them round their hats, under the belief that they thereby secure themselves against the effects of lightning.

Whether there is any real ground for this belief in the protecting effects due to seal-skins and snake-skins is not known; but there can be no doubt that the material and colour of clothing are not without their importance. When the church of Châteauneuf-les-Moutiers was struck by lightning during divine service, two of the officiating priests were severely injured, while a third escaped—who alone wore vestments ornamented with silk. In the same explosion nine persons were killed, and upwards of eighty injured. But it is noteworthy that several dogs were

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present in the church, *all of which were killed.* It has also been observed that dark-coloured animals are more liable to be struck (other circumstances being the same) than the light-coloured. Nay, more; dappled and piebald animals have been struck; and it has been noticed that after the stroke, the hair on the lighter parts has come off at the slightest touch, while the hair on the darker parts has not been affected at all. It seems probable, therefore, that silk and felt clothing, and thick black cloth, afford a sort of protection, though not a very trustworthy one, to those who wear them.

The notion has long been prevalent that metallic articles should not be worn during a thunderstorm. There can be no doubt that large metallic masses, on or near the person, attract danger. Arago cites a very noteworthy instance of this. On July 21, 1819, while a thunderstorm was in progress, there were assembled twenty prisoners in the great hall of Biberach Gaol. Amongst them stood their chief, who had been condemned to death, and was chained by the waist. A heavy stroke of lightning fell on the prison, and the chief was killed, while his companions escaped.

It is not quite so clear that small metallic articles are sources of danger. The fact that when persons have been struck, the metallic portions of their attire have been in every case affected by the lightning, affords only a presumption on this point, since it does not follow that these metallic articles have actually attracted the lightning-stroke. Instances in which a metallic object has been struck, while the wearer has escaped, are more to the point, though some will be apt to recognise here a protecting agency rather than the reverse. It is related by Kundmann that a stroke of lightning once struck and *fused* a brass bodkin worn by a young girl to fasten her hair, and that she was not even burned. A lady (Arago tells us) had a bracelet fused from her wrist without suffering any injury. And we frequently see in the newspapers accounts of similar escapes. If it is conceded that in these instances the metal has attracted the lightning, it will, of course, be abundantly clear that it is preferable to remove from the person all metallic objects, such as watches, chains, bracelets, and rings, when a thunderstorm is in progress. If, on the other hand, it is thought that the lightning, which would in any case have fallen towards a person, has been attracted by the metal he has worn, so as to leave him uninjured, the contrary view must be adopted. Mr. Brydone considers that a thin chain attached in the manner of a conductor to some metallic article of attire, would serve in this way as an efficient protection. Our own opinion is, that, in general, metallic articles belonging to the attire are not likely to have any noteworthy influence, but that such influence as they do exert is unfavourable to safety. We may agree with Arago, however, that "it is hardly worth while to regard the amount of increased danger occasioned by a watch, a buckle, a chain, pieces of money, wires, pins, or other pieces of metal employed in men's or women's apparel."

Franklin recommends persons who are in houses not protected by lightning-conductors, to avoid the neighbourhood of the fireplace; for the soot within the chimneys form a good conductor of electricity, and lightning has frequently been known to enter a house by the chimney. He also recommends that we should avoid metals, gildings, and mirrors. The safest place, he tells us, is in the middle of a room, unless a chandelier be suspended there.

His next rule is not a very useful one. He recommends that we should avoid contact with the walls or the floor, and points out how this is to be done. We may place ourselves in a hammock suspended by silken cords; or, in the not unlikely absence of such a hammock, we should place ourselves on glass or pitch. Failing these, we may adopt the plan of placing ourselves on several mattresses heaped up in the centre of the room. We do not think that such precautions as these are likely to be commonly adopted during a thunderstorm, nor does it seem necessary or desirable that they should be. We have not even the assurance that they greatly diminish the danger. A stroke of lightning which fell on the barracks of St. Maurice at Lille, in 1838, pierced the mattresses of two beds through and through.

That glass is a protection from lightning is an opinion which has been, and perhaps still is, very prevalent; yet there have been many instances tending to prove the contrary. In September 1780, Mr. Adair was struck to the ground by lightning, which killed two servants who were standing near him. The glass of the window had not only offered no effective resistance to the lightning, but had been completely pulverised by it, the framework of the window remaining uninjured. Again, in September 1772, lightning pierced through a pane of glass in a window on the ground floor of a house in Padua, "making a hole as round as if drilled with an auger."

It seems to have been established that if a thunderstorm is in progress, a building is in more danger of being struck when many persons are crowded within it, than when few are present. This points to the danger of the course sometimes followed by the inmates of a house during a thunderstorm. They appear to think that there is safety in society, and crowd into one or two rooms, that they may try, by conversation and mutual encouragement, to shake off the feeling of danger which oppresses them. They are in reality adding, and that sensibly, to any danger there may be. "There is," says Arago, "a source of danger where large assemblies of men or animals are present, in the ascending currents of vapour caused by the perspiration." Like water, moist air is a good conductor of electricity, and lightning is attracted in the same way—though not, of course, to the same extent, by an ascending column of vapour, as by a regular lightning-conductor. It is on this account, probably, that flocks of sheep are so frequently struck, and so many of them killed by a single stroke. Barns containing grain which has been housed before it is quite dry are more commonly struck by lightning than other buildings, the ascending column of moist air being probably the attracting cause in this case, as in the former. When we are overtaken by a thunderstorm in the open air, precaution is more necessary than within a house. It is well to know, especially when no shelter is near, what is the most prudent course to adopt.

It has been stated that there is danger in running against the wind during a thunderstorm, and that it is better to walk with than against the wind. One should even, it is said, if the wind is very high, run with the wind. The *rationale* of these rules seems to be this: a current of air is produced when we run against the wind, the air on the side turned *from* the wind being rarer than the surrounding air. A man so running "leaves a space behind him in which the air is, comparatively speaking, rarefied, and lightning would be more likely to seek such a space for its track than a region in which the air is more dense." An instance is recorded in which, during a gale, lightning actually left a conductor which passed from the mast of a ship to her windward side, in order to traverse the space of rarefied air on the ship's larboard side! But the explanation is more than doubtful, though the fact may be well attested.

It is quite certain that trees are very likely to be struck by lightning, and, therefore, that it is an exceedingly dangerous thing to stand under trees in a storm. No consideration of shelter should induce any one to adopt so dangerous a course. The danger, in fact, is very much greater when heavy rain is falling, since the tree, loaded with moisture,

becomes an efficient lightning-conductor. For similar reasons, it is dangerous to seek the shelter of a lofty building (not protected by a lightning-conductor) in a thunderstorm. One of the most terrible catastrophes known in the history of thunderstorms occurred to a crowd of persons who stood in the porch of a village church waiting till a thunder-shower should have passed away.

In the open air, when a heavy thunderstorm is progressing, and no shelter near, the best course is to place one's self at a moderate distance from some tall trees. Franklin considered a distance of about 15 or 20 feet the best. Henley also considered 5 or 6 yards a suitable distance in the case of a single tree. But when the tree is lofty, a somewhat greater distance is preferable.

The reader need hardly be reminded, perhaps, that the necessity for taking these precautions only exists when the storm is really raging close at hand. When the interval which elapses between the lightning-flash and the thunder-peal is such as to show that the storm is in reality many miles away, it is altogether unnecessary to take precautions of any sort, however brilliant the flash may be, or however loud the peal. It must be noticed, however, that a storm often travels very rapidly. If the interval of time between the lightning and the thunder is observed to diminish markedly, so that the storm is found to be rapidly approaching the observer's station, the same precautions should at once be taken as though the storm were raging immediately around him. So soon as the interval begins to grow longer, it may be inferred that the storm has passed its point of nearest approach, and is receding. But the laws according to which thunderstorms travel are as yet very little understood; and it is unsafe to assume that because the interval between flash and peal has begun to increase after having diminished, the storm is therefore *certainly* passing away. It must be in the experience of all who have noted the circumstances of thunderstorms, that when a storm is in the neighbourhood of the observer, the interval between the flash and the thunder-peal will often increase and diminish alternately several times in succession. It is only when the interval has become considerable, that the danger may be assumed to have passed away.

GEOLOGY IN LONDON.

By W. JEROME HARRISON, F.G.S.

HAVING described the various museums and collections of specimens which are likely to assist the student of geology in London, we may now proceed to consider where he may obtain the active teaching which shall give life to the fossils, and enable the stones to preach their own sermons. First, however, we may mention that since the appearance of our former article the extensive collections formed by the late Henry Christy to illustrate the life of prehistoric man, by comparing his weapons, tools, &c. with those of modern savage tribes, have been arranged in the galleries of the British Museum, Great Russell Street, and are now accessible to the public.

There is another point connected with the first part of our subject to which we may perhaps allude here. The streets and buildings of London are in themselves a geological museum to those who consider them with an observing eye. The pavements are largely formed of flat slabs of sandstone from the carboniferous rocks of the West Riding of Yorkshire—York stone, as the builders call it. Where the horse road is paved with "setts" (cubes of stone about six inches along each edge) these can be seen—after a good shower of rain—to be either a compact black stone, in which case they are a basalt (probably from the Rowley Hills, near Dudley), or a speckled stone formed of crystals of felspar, quartz, mica, &c., constituting a granite or a syenite. The hills of Charnwood Forest, in Leicestershire, yield enormous quantities of stone for this purpose; in the chief quarry at Mountsorrel, which is very visible from the Midland Railway between Leicester and Loughborough, about 700 men find regular employment. The Channel Islands—especially Guernsey—and Cornwall also yield excellent granite, mostly of a whitish colour, but as the stone from these localities can be obtained in large blocks free from joints, it is more valuable for building purposes. The Thames embankment is chiefly of Guernsey granite. As to the materials of which London houses are built, brick is of course the cheapest, because the necessary clay is furnished by the "London Clay," a bed of which, several hundred feet in thickness, encircles the metropolis. The red colour of a common brick is due to a small percentage of peroxide of iron. Limestone—white or yellowish-white in colour—is largely supplied from the quarries of oolitic limestone round Bath in Somersetshire and Portland in Dorsetshire. Westminster Hall and the Houses of Parliament are built of magnesian limestone (*Permian*) from Nottinghamshire. It is easy to distinguish a limestone by the way in which it effervesces when an acid—vinegar, for example, though dilute hydrochloric acid is preferable—is poured upon it. The effervescence is due to the escape of carbonic acid gas. The sandstones, also largely employed for public buildings, come mainly from the millstone grit (*Carboniferous series*) of the north and west of England. The roofing-slates come chiefly from the great quarries in the *Cambrian Rocks* round Snowdon; although the quarries at Swithland and Groby in Charnwood Forest (Leicestershire) have of late years yielded a limited supply. The St. Pancras Hotel is roofed with Charnwood slates.

INSTITUTIONS WHERE GEOLOGY IS TAUGHT.

Until quite lately the Jermyn Street Geological Museum had associated with it a Government Institution known as the "Royal School of Mines," first established in 1851. But lack of accommodation caused a gradual transfer of the students to the "Science Schools" at South Kensington—a large red brick and terra-cotta building in Exhibition Road, facing the Exhibition entrance. The change was completed in 1882, and the Institution is now known as "The Normal College of Science and Royal School of Mines." The teaching of "mining" proper is, however, still continued at Jermyn Street, by Professor Warington W. Smyth, since the splendid collections of models, ores, &c., there accumulated offer special advantages.

At South Kensington the geological class-rooms are at the top of the building, and in the work here Professor J. W. Judd is assisted by Mr. Cole as demonstrator, and Mr. Rutley as lecturer on mineralogy. Professor Judd's name is well known to every geologist. His work on the Geological Survey was excellently done, and his travels on the continent enabled him to write a book on "Volcanoes," which at once became an authority. He is now President of the Geological Society. For those who desire to take the Associateship of the School of Mines a three years' course is provided at South Kensington, and there is no better training in science given anywhere; but occasional students are also admitted to the geological class on payment of 4*l.* for the lectures, and 8*l.* for the laboratory work for the session.

Full particulars are given in a prospectus which can be obtained by application to the Registrar.

Science and Art Department Classes.—There are about twelve classes in geology held in London in connection with the Science and Art Department. Of these we may name the Polytechnic, Regent Street; Birkbeck School, Cambridge Road, Bethnal Green; the Working Men's College, 45, Great Ormond Street, Bloomsbury; the Birkbeck Institute, Chancery Lane; Onslow College, 183, King's Road, Chelsea; St. Thomas' Charterhouse, Goswell Road; City of London College, Moorfields, &c. These classes usually meet one evening per week from September to May. The fees are generally so moderate as to be nominal, but the students are expected to sit at the annual Government examination in May, as grants are paid by the Department for those who pass. These classes are spread all over the United Kingdom, and those who wish for details should send six stamps to the Secretary, South Kensington, for the "Directory" of the Science and Art Department.

University College, Gower Street.—Professor Bonney is here the "Yates-Goldsmid Professor" of Geology and Mineralogy. Professor Bonney stands in the very front rank of British geologists. His special line of work is the microscopical investigation of igneous and metamorphic rocks. The course in geology extends from January to June, and includes lectures, practical work on the rocks and fossils in the College Museum, &c. The fee is four guineas.

King's College, in the Strand, owns Professor Wiltshire as its Professor of Geology. Mr. Wiltshire's *forte* is palæontology, and as Secretary of the Palæontographical Society (established for the purpose of figuring and describing all the British fossils) he has brought out a series of magnificent volumes at a comparatively small expense.

Detailed prospectuses are issued by the authorities of both University and King's Colleges.

SCIENTIFIC SOCIETIES FOUNDED FOR THE STUDY OF GEOLOGY.

The *Geological Society of London* is one of the great scientific societies for whom our Government provides splendid accommodation in Burlington House, Piccadilly. Although the society is styled as "of London," its members are recruited from every part of the British Empire. Ever since its foundation in 1807 the society has steadily increased in numbers and influence, and the letters F.G.S. appended to a man's name have always been accepted as a guarantee of *some* knowledge of geology on the part of the possessor. Candidates for membership must be nominated by three fellows of the society, to one at least of whom they must be personally known. The names are read out at three meetings of the society, and a ballot is then taken. The entrance fee is six guineas, and the annual subscription two guineas. The present number of members is about 1,450. The meetings are held at Burlington House at eight P.M. on the first and third Wednesdays of each month from November to June inclusive. All our great geologists have held office in connection with the Geological Society; and the present President, Professor Judd, is a worthy successor of the great men who have preceded him. The society has an admirable library and museum, which are open to fellows and their friends from ten to five daily. The "Quarterly Journal" of the Geological Society contains the papers read before the society, and is a well edited and illustrated periodical. It is sold to non-members at five shillings per number. Mr. W. S. Dallas, Burlington House, is the able and courteous Assistant-Secretary, Librarian, and Curator.

The Geologists' Association was founded in 1869. Its object is, in addition to the reading of papers on geological subjects, to instruct its members by Saturday afternoon excursions to museums and places of geological interest near London. At holiday times places more distant are visited, and in this way the association has covered most of England, and has even crossed the Channel to examine the rocks of France and Belgium. The head-quarters are at University College, Gower Street, where there is a good library of geological books at the disposal of the members. The entrance fee is ten shillings, and the annual subscription is of the same amount. The number of members is nearly 500, and the Secretary is Dr. Foulerton, F.G.S., 44 Pembridge Villas, W. The "Proceedings" of the society are published quarterly, and are sold to non-members at 1*s.* 6*d.* each. This is a society which has done, and is doing, excellent work. The leaders of the excursions are always geologists of high standing, while the curators of the museums and other places visited seem always anxious to further the objects of the association.

Perhaps, in conclusion, a word may be said on the text-books of geology suitable for the student. For young people—and indeed for oldsters too—there is no better introduction to geology than Professor A. Geikie's two little "Primers" of geology and physical geography, published by Macmillan. These should be followed by Professor Huxley's "Physiography," in which a most admirable and detailed account of the physical features of the Thames Valley is given. Then Professor A. Geikie's larger "Class-book of Geology" may be mastered; and the same author's great "Manual of Geology" with Lyell's "Student's Elements" and Professor A. H. Green's "Physical Geology" will complete our list.

Those who desire to study the geology of any particular spot in England or Wales will find my "Geology of the Counties," published by Kelly & Co., useful as a book of reference. The special books and papers treating of the strata under and around London will be mentioned in my next article.

STAR-BORN METEORS.

By Richard A. Proctor.

WHEN Copernicus had shown the sun to be the true centre of the planetary motions, Tycho Brahe pointed out that, if this is so, a result of the most startling kind must be accepted, a result which he for one rejected altogether. His own observations, which eventually proved the very basis of the new theory, he bequeathed to the world with the express injunction that they should not be used in its support. He reasoned that if the earth really moves around the sun, the unchanging aspect of the constellations cannot but mean that the stars are thousands of times farther from us than the sun! It is not merely, he argued, that the eye sees no change; the great quadrant of Uranienberg, by which I could detect a displacement of less than a minute of arc, shows no displacement at all in the position of any star as the earth sweeps round her immense orbit. If this preposterous theory—this unholy theory—is true, we should have to set the stars at such distances that each would be a sun—which is altogether inadmissible.

We know how even the vast stellar distances thus indicated were found to be as nothing compared with the distances indicated when more exact instruments were made. The estimated distance of the sun has been increased about thirty-fold; the heavenly arcs measurable by modern instruments have been reduced a hundred-fold. Each change

has thrown the stars farther into space in corresponding proportion, so that, instead of the stars' distances being measured by thousands of millions of miles, they must be measured by millions of millions, perhaps by hundreds or thousands of millions of millions of miles. Yet now the doubts of Tycho Brahe have entirely vanished. We *know* that what he rejected as impossible is the simple truth. Nay, the discoveries made with the telescope show that what he held so marvellous is but the merest nothing compared with the real truth. For, far beyond the stars of which Tycho Brahe knew, exceeding them millions of times in number, lie the stars revealed by the telescope, and these also, like their brighter and (on the whole) nearer compeers, show no measurable displacement as the earth circles round her mighty orbit, a hundred and eighty-five millions of miles in span.

A discovery recently made leads to a result almost as amazing as that rejected by Tycho Brahe; nay, so amazing that it has long led astronomers to reject, as he did, what would have seemed fairly demonstrated were it not for the incredible nature of the conclusion which must be accepted along with it. In this case, as four centuries ago, it is the earth's orbital motion which is in question. I might, indeed, almost say that the earth's orbital motion would be rendered doubtful by the new discovery, if the accumulated proofs of the earth's revolution around the sun were not overwhelming. Again it has been shown that the earth's motion around the sun, vast though her orbit is, and tremendous the velocity with which she moves, produces no appreciable effect where one would expect its effect to be most marked.

Meteoric astronomy has latterly been fruitful in remarkable discoveries. Within the last quarter of a century, the position of meteors in the universe has been made more and more remarkable by a series of discoveries of singular interest. The views of Prof. Olmstead, of Hartford, Connecticut, which had been overlooked save by a few of the bolder thinkers when first advanced, have not only been established, but details which he could not indicate have been determined, and meteor systems shown to be far more remarkable even than he had imagined. They have been recognised as crossing our own earth's track in hundreds, while within the solar system astronomy has learned to recognise millions of millions, not of meteors, but of meteor systems, each containing trillions of trillions of individual meteors within its limits. And now peculiarities have been recognised which compel us to raise our conceptions of the range and number of these systems far higher, to recognise them as including not only interplanetary systems countless in number, and as we had thought amazing in range and extent, but as extending into the interstellar depths, across those seemingly illimitable spaces which separate our sun from his fellow-suns among the stars. Moreover, we recognise that even our ideas respecting the origin of these bodies must be widened, that theories which had been regarded as reasonable and probable must be rejected, and other theories which had seemed too amazing to be thought of, must be entertained.

Let me here briefly recapitulate the evidence on which accepted theories (here I speak of theories really accepted and demonstrated) had been based, in order that the bearing of the new discovery may be clearly recognised.

It had been shown by Olmstead that because showers of falling stars, of the same character, recur on particular days (or nights) of the year, therefore they must be due to the earth's passage through flights or streams of meteors crossing her orbit at certain definite points; for a day in the year is the time when the earth in her motion around the sun reaches a particular part of her orbit. He had shown further that the behaviour of meteors belonging to these showers corresponds with this theory, or rather with this demonstrated fact; for they are invariably found to radiate from a particular point, or small region, of the heavens. That is to say, if the tracks of the meteors seen during any great display are marked down on a celestial globe, or on a map so planned that the paths of meteors, however long, would be represented by straight lines, these tracks, carried backwards in great circles on the globe, or in straight lines on the map, all pass through or very near a certain fixed point on the celestial sphere. It matters not where the observer may be who watches the display—in England, or in America, or in Asia, Africa, or Australia—the same law holds: except for straggling meteors which belong to other systems, every meteor of the display has a track which, carried backwards, is found to extend from the proper "radiant point" for that system, the radiant being unchanging among the stars. Nor does it matter how long the display may last, or how far the radiant may be shifted with respect to the horizon; among the stars it always has the same position. Olmstead showed the meaning of this, though indeed the meaning should be obvious. A series of parallel lines, or lines directed to the same point in remote space, always appear to radiate from a point, if they are complete; and if parts of them only are seen (as is of course the case with meteor tracks), these parts always have *directions* radiating from that point. Hence meteor paths in our atmosphere are all parallel: and as the point from which they radiate is unchanging in the star-sphere, the direction of parallelism does not change as the earth rotates, and the paths must therefore have been parallel before the meteors entered the air. Thus, the meteors are bodies travelling with velocities so great that neither the motion of the observer round the earth's axis, nor the effect of the earth's attraction on the meteors as they near her, has any effect in altering either the apparent or the real direction of meteoric motion.

This demonstrated result was far from being generally accepted. Alexander Humboldt, with that clear-sightedness which characterised him, even when he was dealing with matters outside his especial range of research, accepted Olmstead's conclusion at once. He recognised meteors and falling stars as travelling with planetary velocities, and even described them quaintly as "pocket planets."

In 1866 new light began to be thrown on Olmstead's demonstrated theory. It was found, first, that the orbits of some meteor systems are such as to carry the meteor families far beyond the paths of even the remote planets Uranus and Neptune. Then it was discovered that some meteor flights travel in the tracks of known comets, as the August meteors in the path of the bright comet of 1862, the November meteors in the path of Tempel's comet of 1866—one having a period of 105 years, the other a period of 33¼ years. But this was not all. Recognising the connection between comets and meteors as demonstrated, I threw out in 1872 the suggestion, or prediction, that when the earth crossed, during the last week of November, the path of Biela's comet, which in that year had crossed the earth's path (though, broken up and disintegrated as the comet had long since been by the sun's action, no telescope had detected its filmy texture), there would probably be a display of falling stars; and on the night of November 27, 1872, the display was seen. Hundreds of thousands of falling stars, all radiating from the part of the heavens corresponding to the known track of the comet, were seen that night; and the whole of the radiant region, at one part of the display, was full of amber-tinted light. Here, then, was another meteor system associated with a comet, and that, too, in a manner which removed even such shreds of doubt as might still have remained in the minds of the more cautious astronomers.

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It seemed certain that all meteor systems were associated with comets, all comets followed by trains of meteors, though the origin of meteors and of comets alike, remained still enshrouded in mystery.

Beyond this, indeed, nothing had been proved. Schiaparelli's guess had never been more than a guess—that meteor systems originally travelling along amid the interstellar depths had been drawn into the solar sphere by the sun's action, and that some among them which had chanced to pass near enough to the giant planets to be deprived of a sufficiently large portion of their velocities had been compelled thenceforth to travel on the closed paths recognised in the case of every meteor system yet satisfactorily dealt with. Nay, I think I may say, without showing undue confidence in my own accuracy, that the reasoning sketched in my article on the origin of comets in the *North American Review* sufficed to demonstrate that, whatever the real truth in the matter, Schiaparelli's idea could not possibly be sound. The velocities with which meteors drawn *even from rest* towards the sun would cross the paths of the giant planets, would be such (*demonstrably*) that those planets could not possibly capture the meteor systems, as such, in the way imagined by Schiaparelli.

On the other hand, I advanced a theory whose real force, in my opinion, lay then in the circumstance that it appeared the only theory available; though there was also very strong positive evidence, even then, in its favour. I suggested that as the sun is known to have the power of ejecting bodies from his interior with velocities sufficing to carry them for ever away from him, and as microscopic evidence, chemical evidence, and physical evidence had combined to show that some meteors were once in a condition in which they could never have been save in the interior of bodies like the sun, and his fellow suns the stars, *some* meteors and meteorites have been expelled from suns, and have reached our system after journeys, lasting millions of years, through interstellar space. This, of course, did not account for the meteoric systems associated with the giant planets, as already mentioned—that is, for those systems which, as they pass very near the orbits of the giant planets, had led to Schiaparelli's ingenious but inadmissible theory that they were originally captured by those planets in their swift rush past their mighty orbs. But my theory about the ejection of some meteors from suns like our own was but part of a wider theory. I have long maintained, and it is now I think generally admitted, that every orb in the solar system has once been in a state of intense heat—in fact in a sunlike state. The giant planets have more recently ceased to be suns (in glory as well as heat) than the earth on which we live, or her fellow terrestrial planets Venus, Mars, and Mercury; while the glowing stage of the moon's existence must be set yet further back still. Now when a giant planet was a sun it must have resembled our sun in having the power of gathering its eruptive energies from time to time in such energetic throes that flights of missiles would be ejected from its interior with enormous velocities. Supposing these velocities much less in the case of Jupiter or Saturn than in the case of the great central sun, still they might well be such that the ejected masses would never return to the parent planet; for the simple reason that much smaller velocities would be required to eject missiles beyond Jupiter's back-drawing power, than to eject missiles beyond the much mightier back-drawing power of the sun. Now flights of multitudinous small missiles, ejected in mighty volcanic throes from the interior of Jupiter, would account perfectly for the comets and their associated meteoric attendants which hang around the orbit of Jupiter. And in like manner would the remarkable comet families of Saturn, Uranus, and Neptune be explained.

But we may go a step further in this direction. It has been shown by M. Stanislas Meunier, Tschermak, and others, that among the meteors which fall from time to time on our earth are some which cannot readily be explained unless we regard them as having been once ejected from our earth itself. Of course, the ejection of bodies from the earth to considerable distances had always been regarded as among possible and even probable events. Laplace and Lagrange had considered the problem of such ejection in relation to the theory advanced by Olbers that the asteroids may be the fragments of a former planet, ejected in so mighty a throe that the whole planet went to pieces in its progress. And among the conclusions they deduced was this—that a planet like our earth might very readily eject masses from its interior with such velocities that they would travel thenceforth around the sun as a centre, though with paths intersecting for ever thereafter the orbit of the parent planet. Thus, while a mass ejected from the earth with less velocity would return straightway to the earth, its path necessarily intersecting her globe (since it originated from her globe) these more swiftly ejected missiles would travel on paths which might leave them free to travel for thousands or tens of thousands of circuits around the sun, though eventually the time would probably come when in crossing the earth's orbit they would find the earth herself at the crossing-place, and end their career by returning to the globe from which they had been ejected. Ball has shown that quite a large number of the meteors which fall on the earth most probably had such an origin and such a career.

Now, there is no reason for excepting our earth from the general rule already extended from suns to giant planets. If the theory of the ejection of matter from the sun's interior so that thenceforth it travels meteorwise through space be sound (and it is based on direct evidence), and if the theory of the ejection of matter from the giant planets when in the sunlike state be sound (and it serves to explain the remarkable comet families of the giant planets, apparently explicable in no other way), then we cannot but admit the likelihood, or rather we must recognise the certainty, that the earth also when young and sunlike must have possessed similar power. The power would be less, of course, being proportioned to her mass; but her mass measures also the force which has to be overcome in order to get meteoric matter away with such velocity that it would be beyond the earth's recalling power. Thus, then, while on the one hand weighty evidence tends to show that in the remote past meteoric masses *have* been expelled from the earth's interior so as to travel thenceforth around the sun as their centre, a theory based on direct evidence tends to show that in her youth the earth must have possessed the power to eject such masses from her interior with the necessary velocities. (*To be concluded.*)

Notes.

The following extract from the official report of the autopsy on the body of Mr. R. A. Proctor, which was sent to the President of the New York City Board of Health, supports the opinion expressed by the Florida medical officials (see page 3) and by Mr. Proctor's relatives, that his death was not due to yellow fever, but that he was suffering from *malarial fever*, when he was exposed on the wet and miserable night of his removal from the New York hotel. The medical man in attendance proposed to take him to the Hospital for infectious diseases at North Brother's Island. But finding the night so stormy, he did not dare to carry him further than a Hospital in Sixteenth Street, not devoted to infectious diseases, where he was taken in at one

o'clock in the morning and placed in an empty ward. He shortly became unconscious, and died the same evening. It is a question for consideration whether the deaths brought about by the official precautions adopted during yellow fever and cholera scares do not outnumber the deaths due to the dreaded scourges themselves. In the particular instance under consideration, it does not appear certain that if the case had been really one of yellow fever, the danger of infection would have been diminished by his removal down the hotel stairs and through the streets. The report states that—

"The only positive change due to disease which could be made out was in the kidneys, which showed the appearance of old, though not advanced, disease. The alterations produced in the body by yellow fever are usually of such a character as to be nearly or completely obliterated by such advanced decomposition as the organs presented. We are, therefore, only able to say in this connection that there was no other evident cause of death, and nothing which would be incompatible with death from that disease. The final conclusion as to the cause of death must, therefore, in our opinion, be largely based upon the clinical history.

T. Mitchell Prudden, M.D.,
Hermann M. Briggs, M.D.,
Pathologists to the Health Department of New York City.

* * *

Admiral Mouchez, the Director of the Paris Observatory, where experiments are now being made with regard to the plates to be used for the photographic charts of the heavens, reports that he has received from America some plates which are superior in sensitiveness to any that have been previously employed. The American plates have been tried by the MM. Henry, who report on them most favourably as to the uniformity of film and extreme sensitiveness. They have been able to obtain with one hour's exposure results which were obtained with difficulty in two hours with the best European plates. This is most satisfactory, as the great length of exposure required for fainter stars is one of the chief difficulties in the way of the execution of the photographic chart.

* * *

The electro-melting process for making aluminium alloys may exercise a considerable influence on the arts in the future. For, according to a paper read before the Franklin Institute by Mr. Pemberton, there is hardly any metal with which aluminium will not alloy, and it alloys with nothing that it does not improve. Aluminium bronze is the strongest of the cast metals, and, when rolled, the strongest of rolled metals. It does not corrode, as ordinary bronze does, and its fine golden colour gives it a pleasing appearance. Aluminium brass is noted for its great strength and high elastic limits. Aluminium iron is now extensively used for castings, for the fusing point of wrought-iron is reduced almost 500° by the addition of only one-thousandth of its weight of aluminium.

ANOTHER UNDECIPHERABLE CIPHER.

(*To the Editor of* Knowledge.)

I WAS much interested in your cipher in the July number. It is no doubt quite undecipherable in the absence of the key, being based upon the principle of fluctuating signs, which is the only practical principle for a real cryptogram. That is to say, that A shall not always be written down as *x*, but also as *y*, *z*, &c. Your method of obtaining the fluctuations is ingenious and comparatively easy, much more so than the old "Chiffre indéchiffrable"

a b c d
b c d e
c d e f &c., &c.,

used with a prearranged key-word. I doubt, however, whether you gain much by the knuzthelofy part of your system. Is there any real need to indicate the number of letters in each word? Instead of recommencing 2,015, &c., at the beginning of each word, you might run the 20,153,401, &c., right through the message. After a cryptogram has been translated back into a message, the latter is quite legible even though the divisions between the words be not marked. If my suggestion were approved of, you would save writing down the number of letters in each word (2, 3, 8, 2, 3) on your paper of preparation, and also save writing down the corresponding key-word (*nutnuy*) at the commencement of the cryptogram.

I also have invented an "Undecipherable Cipher." It is on the principle of fluctuating signs, but I obtain the fluctuations by quite a different plan to yours, and I should be glad if you will allow me to submit it to a trial by experts in the columns of your paper.

Take any six letters of the alphabet, say, for example, *a c o s u v*. Make them into combinations of twos, thus, *a a*, *a c*, *a o*, &c., in all thirty-six combinations. These will be our signs. Distribute the letters of the alphabet, A B C D E, &c., in any order whatever, amongst the above combinations. This will absorb twenty-six of the combinations. Amongst the remaining ten I distribute an additional letter E, the words And, The, You, the "Letter Repeat," and three "End of Word." The use of these will be explained below.

Our code will now stand thus, for example:—

No. 3.					
	a a	F		s a	W
	a c	I		s c	Y
	a o	V		s o	M
	a s	T		s s	E
	a u	End of Word *		s u	End of Word *
	a v	D		s v	N
	c a	K		u a	L
	c c	G		u c	Q
	c o	E		u o	X
	c s	S		u s	H
	c u	Z		u u	O
	c v	R		u v	Repeater
	o a	C		v a	The
	o c	End of Word *		v c	
	o o	J		v o	And
	o s	A		v s	You
	o u	P		v u	
	o v	B		v v	U

Three or four codes may be prepared, all of course different.

The first rule for writing the cryptogram is to write all words continuously—that is, without any spaces between them. Thus "We are" would appear as *sacooscvss*. So far, however, the combinations of two letters would in reality have only the same effect as single characters. An enemy, or investigator, by commencing at either end, and dividing the letters into groups of two, would have practically a certain number of single signs, with which he could deal further after the usual analytical methods employed in decipherment.

I come now to the cardinal point and distinguishing feature of my system. At the end of each word the double sign (*au*, or *oc*, or *su*) is written to denote the end of the word, and, after the double sign, a *single* extra false letter (in Code No. 3 either *a*, *c*, *o*, *s*, *u*, *v*) is inserted. *The effect of this single false letter is virtually to change all the succeed-*

ing combinations. Consequently the investigator, though he may divide the cryptogram into groups of two letters, will not succeed in getting at the actual combinations used, but will get others quite different and of no use for his purpose. If an investigator cannot individualise the characters of a cryptogram, how is he to proceed to analyse it? To further guard against certain vulnerable points of cryptograms in general I employ the following simple devices:—

In double letters the second letter is written by the "Repeater." Thus, tt=*asvv*. E has two signs, which are to be used alternately. "End of Word" has three signs, which are to be used alternately. The words "And, The, You" are each expressed by a single sign. This also saves time in writing.

Now for a message. "We are prepared to act" will be written thus:—

No. 3. sacoauvoscvssocuoucvcoouo
scvssavsusasuuauoosoaasocc

This may at first appear longer than a single-letter system, but it is really quicker both to write and to read, because in the single-letter systems the sender must write down the key underneath the whole of the message on a separate piece of paper before commencing his work, and the receiver must likewise write down the key underneath the whole of the cryptogram before he can begin to decipher it. By my method, however, the sender, with his code before him, can jot down the message straight off without any preparation, and the receiver can decipher it in a similar way with even greater speed.

There are some other devices and variations which may be introduced into the system, but I have perhaps said enough to explain the *modus operandi*.

By-the-by, Bacon's five-letter cipher did not fulfil his own condition. It was on the fixed-sign principle, and was decipherable with but little difficulty.

Edward Anderson.

ON A GREAT BRANCHING STRUCTURE IN THE CORONA OF AUGUST 29, 1886.

AMONGST the photographs obtained by the American and English observers who visited the island of Grenada to observe the eclipse of August 29, 1886, is one which, according to the report of Professor W. H. Pickering, shows some enormous structures extending to a distance of nearly two solar diameters from the sun's limb.

The most remarkable of these is a narrow jet in the south-west quadrant which starts from the centre of a group of rays which bend together forming what has been termed a synclinal group, the outer rays of which are inclined inwards from the radial, and then slightly curve together so as to form a hollow cone. There are many such groups on photographs which have been taken during other eclipses, but what is exceptional about this particular group is that from its summit there rises a narrow nearly radial jet which extends without curving to a height of forty-eight minutes of arc (more than a solar diameter and a half), and then divides into three branches, one of which falls over with a crook-like curve towards the western equatorial region, another bends over towards the South Pole, and the third reaches an elevation of sixty minutes, and then falls back towards the equatorial region. To the south of this group is another gigantic jet, which starts with an inclination of twenty degrees or more from the solar radius, and bends over as if it belonged to the same synclinal group, or was under the influence of similar forces to those which caused the bending of the lower rays. This great ray bends over until it appears to cross, or come up to, the hooked ray just below the level at which it branches. The diagram is made from a drawing which Professor W. H. Pickering kindly sent me in a letter shortly after his return.

The larger scale drawing (fig. 2) is made from the frontispiece of the Report of his Expedition recently published. Unfortunately, there is only one photograph showing this remarkable structure, but Mr. W. H. Wesley has in the last number of the *Observatory* put together the outline drawings of this corona made by three observers, which show that as seen with the naked eye there was a great projection at this part of the corona, and the photographs of the English observers, Mr. Maunder and Professor Schuster, corroborate Professor Pickering's photograph as far as they go, that is, they show the synclinal group of structures at the base of the great ray, but the English photographs were taken with longer focussed instruments than that with which Professor Pickering's photograph was taken, and the image thrown upon the photographic plate was less brilliant though larger, consequently the upper and fainter parts of the corona which registered itself with Professor Pickering's instrument cannot be traced upon the English photographs.

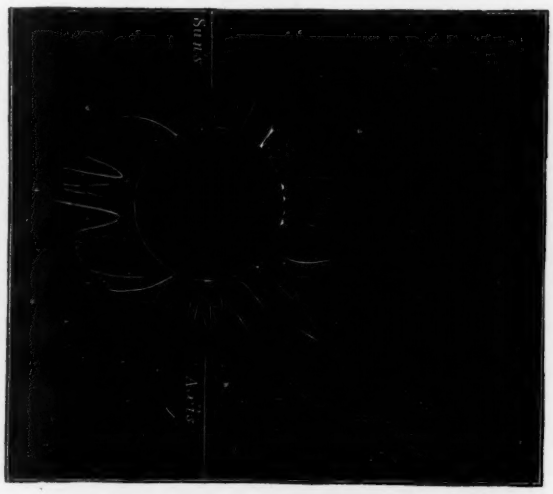


Fig. 1.—Outline from Professor Pickering's Drawing.

The structures in question are of a similar character to coronal structures shown on other photographs; for example, the English photographs taken in India during the eclipse of 1871 all show a hook-shaped ray, which, however, does not extend to an altitude of more than eleven minutes above the solar limb, where it divides into two branches which curl over in opposite directions. The main stem or jet is not radial to the sun's limb, but is inclined to the normal at an angle of more than twenty degrees. This curious jet, the photographic evidence with respect to which is quite conclusive, is shown in fig. 3. Its outline is somewhat hazy, as is the case with the jet shown in Professor Pickering's photograph, and it is seen as a somewhat brighter object on a nebulous background. Though it appears small compared with Professor Pickering's jet, it extends to an altitude above the sun's limb greater than the moon's distance from the earth, while the summit of Professor Pickering's jet reaches an altitude of more than a million and a half miles above the solar surface. My intention in this paper is to

inquire what can be the physical explanation of such structures?

The inclination to the radial and the falling back again of the branches towards the solar surface, would seem to show that these structures cannot be due to matter acted upon by a repulsive force similar to that which drives the matter of a comet's tail away from the sun. And these strange forms cannot be explained as due to explosive jets of gaseous matter thrown upward into the coronal region and falling in free space under the influence of gravity alone to the solar surface. Such jets would, in whatever way they were foreshortened by projection, always appear either as straight lines or conic sections about the sun's centre. For a trajectory curve will be projected into a straight line if seen from a point in its plane, or into another conic section if seen from a point outside the plane of the trajectory. The hooks of the great

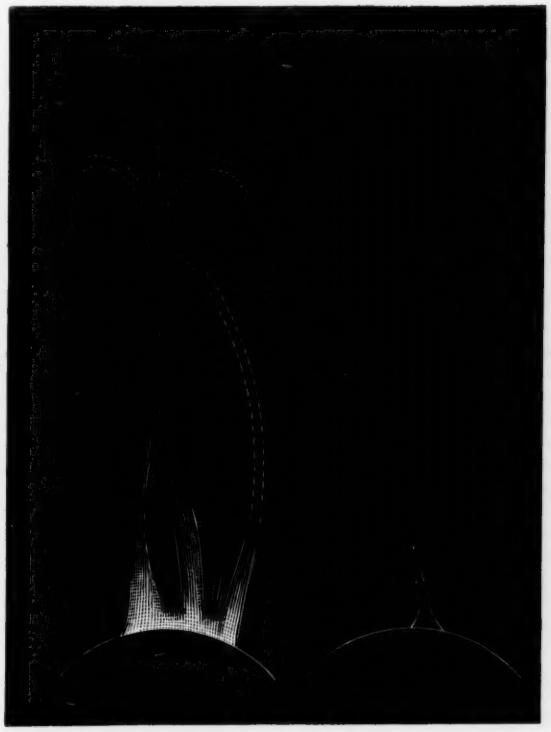


Fig. 2.—Large Scale Drawing of Structure in 1886 Corona.

Fig. 3.—Outline on similar Scale of Structure in 1871 Corona.

jet in the 1871 corona are certainly not conic sections, neither are the branches of Professor Pickering's ray. If in the latter case the three branches belonged to three jets shot up in identically the same path, or all shot up in the same plane one behind the other, so that as seen in projection the upward branches of the trajectories overlapped, the downward branches could not curve away in opposite directions under the influence of solar gravity. Possibly the left-hand hook may belong to the great structure which rises from a part of the limb nearer the South Pole, and the right-hand hook may be the summit of a structure curving from the other side of the synclinal group; but if so, its lower part is fainter and lost to view. One is only driven to such a supposition by the difficulty of conceiving of an explosion at such an altitude producing branches. Clearly we must give up the trajectory theory as being insufficient alone to account for all that is observed. Possibly a theory which supposes jets to be thrown up in true trajectories and afterwards drifted by a resisting medium may be sufficient to account for the observed forms, but there are many mysteries which still have to be cleared up. Why, for example, in the case of Professor Pickering's great ray, should the falling branches be drifted, while the upward branch remains absolutely straight.

It may be useful here to point out some of the possible changes in the form of a structure which may be due to perspective. A straight ray whose direction passes through the sun's centre cannot be projected so as not to be radial to the sun's limb; but a straight ray which appears radial as seen in projection, may possibly be inclined to or from the observer, and may be very far from normal to the sun's surface at the part of the photosphere from which it springs. A ray which does not appear radial as seen in projection cannot be normal to the solar surface. There is ample evidence in the coronal photographs of the existence of such oblique rays. It is difficult to conceive how explosions from a gaseous body like the sun can give rise to oblique rays, but their existence is beyond dispute. They are, I believe, without exception brighter, and they are frequently broader in their lower parts—sometimes appearing to spring from a broadened base like a bulbous root, which may be due to a real broadening of the ray, or to overlapping smaller rays at its base.

Some of these oblique rays are straight, or nearly straight, while others show considerable curvature, and others bend over in one direction in their lower parts, and are again carried slightly in a contrary direction above. The existence of these curving rays, showing contrary flexure, is a matter of considerable importance, as they appear to indicate the existence of an atmosphere with currents carrying the matter of which the structures are composed with different velocities at different altitudes.

And yet anything like a gaseous atmosphere, where each layer presses upon and is supported by the layer beneath it (as in the case of the terrestrial atmosphere), is inconsistent with other solar phenomena. For example, it is inconsistent with the small amount of light dispersed by the corona, and it is inconsistent with the narrow spectral lines given by the prominences which correspond with a gaseous barometric pressure of less than a hundredth of a terrestrial atmosphere; with solar gravity in the prominence region twenty-seven and a half times greater than terrestrial gravity at the earth's surface, it follows that, if the solar atmosphere were in static equilibrium, the pressure would (assuming uniform temperature) be doubled at a level an eighth of a mile lower; at a depth a mile and a quarter lower down the pressure would be multiplied by 2 to the power of ten, that is, it would be more than a thousand times as great as at the upper level; at a depth of five miles the pressure would at this rate be more than a million million times as great. No reasonable assumptions with respect to rapid increase of temperature would counterbalance such an overwhelming rate of increase of pressure. The gaseous molecules and dust particles which spectroscopic and polariscopic observations show are present in the corona, must either be moving freely in very long trajectories, or they must be maintained in position by some force counterbalancing gravity, similar, for example, to the force which repels the matter of a comet's tail.

Be that as it may, there is certainly resisting matter in the coronal region which retards the upward flight of the matter of solar prominences. This was first definitely shown to be the case by Mr. Proctor, and was an important step in the solar theory. In a paper published in the *Monthly Notices* of the Royal Astronomical Society, for

December 1871, he compared the velocity of the matter of a hydrogen prominence observed by Professor C. A. Young with the velocity of a projectile thrown upward in free space under the influence of solar gravity, and showed that the observed velocity indicated that the prominence matter was moving in a resisting medium. There are not many cases in which suitable observations of the velocity of the rise of a great prominence have been made, but I have since made a similar calculation with respect to another great prominence observed by Professor Young in October 1879, and have derived a similar result. The motion of comets with close perihelion distances also points in the same direction, and there seems to be little room for doubt that the jets of coronal matter as well as the prominences are projected into a resisting medium which is itself in motion, and rapidly modifies the projection forms.

A. C. Ranyard.

FAIRIES OF FRANCE, ITALY, AND SPAIN.

By Mary Proctor.

IN olden times the peasant in Gaul believed that wondrous deities haunted every stream and dale. Even now, as the village dames sit at their cottage doors knitting, the children gather round and listen eagerly to the oft-told tales of those good old days. But dainty little fairies have now taken the place of gods and goddesses.

They are very beautiful, and particularly fond of dancing in fairy rings on the green sward, which are called Cercles des Fées, but woe to anyone who approaches whilst the fées are dancing therein. They are forced to join in the dance, and, as they whirl round faster and faster, they become so weary that they fall down exhausted, and are lucky if they escape with only a few bruises.

Near the village of Puys there is a high plateau where the "fées" used to hold fairs, at which they sold magic articles taken from their secret stores. They would use all their persuasive powers to make mortals buy these, but when the purchaser would hold out his hand to take the chosen article, the perfidious "fées" would hurl him down the side of the cliff.

In days of old a merry band of fairies haunted Normandy, and were called Les Dames Blanches. They were always on mischief intent, and would hide themselves in dark nooks and narrow ravines ready to spring out on the unwary traveller. They would often insist upon his dancing with them, and, after a round or so, they would dismiss him gracefully, but should he refuse, they would fling him into a ditch full of briars and thorns.

A very imperious Dame Blanche once haunted a narrow bridge over the Dive, in the district of Falaise. She would not let anyone pass by until they went down on their knees to her. If they refused, they were delivered over to the tender mercies of the lutins, cats, owls, and other creatures over whom she held sway.

Lutins were little beings, very much like the kobolds and nisses of Scandinavia and Germany. They would be very kind to little children when they were good, and give them cakes to eat, but, when they were naughty, the lutins would pinch them and make them feel very sorry.

A story is told about an old grandmother who had a great deal of trouble with seven little boys. They would play on the seashore after dark, and she was always afraid something dreadful would happen to them. One evening, when they were having an especially fine frolic, a little boy spied a pretty black horse, and he suggested to the others that they should all get on his back and ride home. So they mounted the horse, and on their way home they met several of their playmates, whom they invited also to take a ride. Now, it may appear strange, but the little horse had conveniently stretched its back so far that it carried thirty little boys quite easily. Imagine their horror, however, when the magic steed suddenly bolted with them into the sea, and, plunging far under the waves, the naughty little boys were all drowned.

Another lutin, named Le Petit Homme Rouge, was very angry with some little children who made fun of him. He pelted them so hard with stones that they hid themselves under an old fishing-boat. They heard the shower of stones on every side; but, when they at last ventured to peep out, not a stone was to be seen. Nevertheless, they had learned a good lesson, they were not likely to forget in a hurry.

There are fairies resembling the lutins who have been known to steal horses out of the stables and take many a wild ride across the country. They would sit on the horse's neck, and plait the mane together for stirrups. Sometimes they would work with the tools they found in the stables, but everything would be in perfect order next morning, and the tools mended if they needed repair. Besides, the farmers liked to have the bright little beings around the place, for they invariably brought good luck, and were kind and obliging, helping those whom they liked with their work.

The Esprit Follet, or Gobelin of the North of France, resembles the domestic sprites of Germany, and is full of mischief. They haunt the cottages of the peasants, and pelt people with sticks and stones as they pass in and out of the doors. Though their little cracked voices are often heard, yet they have never been seen, so that it is impossible to drive them out. They have been known to enter houses suddenly, taking children out of their cradles, blowing out the lights, and even worrying those who were sleeping. The peasants found to their great distress that all the holy water in the church was of no avail against these mischievous sprites!

In Besançon, the meadows are supposed to be haunted on dark nights by these frolicsome little beings. A charming account is given of one in the story of "La Petite Fadette."

"C'était vraiement une vilaine chose à voir. Tantôt il filait comme un martin pêcheur, et tantôt il disparaissait tout à fait. Et d'autres fois il devenait gros comme la tête d'un bœuf, et tout aussitôt menu comme un œil de chat; et il accourait auprès de Landry, tournait autour de lui si vite, qu'il en était ébloui, et enfin, voyant qu'il ne voulait pas le suivre il s'en retournait frétiller dans les roseaux où il avait l'air de se fâcher et de lui dire des insolences."

In the south of France the peasants still believe in fées, or fadas, as they are sometimes called, and there is not a village in Languedoc without some little nook or spring frequented by them.

In Provence a special feast is prepared for them on the night of December 31. A room is set apart for their use, and the doors and windows are left open as an invitation for them to enter. A table is spread with a snow-white cloth, on which are placed a loaf, a knife, a vessel full of wine or water, a plate, and a lighted candle.

According to the old romances, three fées would go to each house:—

Coustume avoient les gens, par vérités,
Et *en Provence* et en autres regnez.
Tables métoient et siéges ordenez,
Et sur la table iij blanc pains bulétez,
Iij poz de vin et iij hénez de lès
Et par encoste iert li enfès posez.*

* Possibly G. Sand's story of "Les Dames Vertes" was founded on this myth.

In the Romance fairy tales, as in the French, the old Roman gods gradually assumed the nature of wood sprites and fairies. The Lars, closely akin to the Gothic dwarfs, were supposed (like the Grecian heroes) to be the souls of men who after death were doomed to hover about their former abodes.

The fata of Romance tales were supposed to exercise a wonderful influence over the destiny of mortals. There were, according to the Italian poets, black and white fates, good and bad.

The most celebrated, called the Fata Morgana, was the queen of the fairies, and the wonderful mirage to be seen at Messina was supposed to be a reflected image of her palace under the waters. She is the goddess of fortune, and subject, with all the fates and witches, to the terrible Demogorgon. According to Ariosto, he has a splendid temple-palace in the Himalaya, where the fates are all summoned to appear and give an account of themselves every fifth year.

"They travel through the air in various strange conveyances, and it is no easy matter to distinguish between their convention and the Sabbath of the witches." *

A fata, called Silvanella, was supposed to have built a tomb over Narcissus and then dissolved away into a fountain. When the tomb was opened by Brandamarte (an Italian hero), a hideous serpent put forth its head. He kissed it, and it gradually changed into a beautiful maiden, possibly Silvanella.

Among the collection of fairy tales to be found in the Pentamerone, the following is related about the fairy Colina.

A poor fisherman had had so much ill-luck that at last, in despair, he called on the Enemy to help him. The latter did so, on condition the fisherman should give him his youngest son when he was thirteen years old. The fisherman agreed to these strange terms, and from that day was always successful.

At last the time arrived for the Enemy to claim the boy, and the fisherman bitterly regretted the rash promise he had made. He had not the heart to see the boy taken, so he placed him on the beach at the appointed place, and bade him wait till he returned from his fishing.

The boy amused himself by making wooden crosses, and sticking them around him in the sand. When the Enemy appeared and saw these crosses, he frowned at the boy, and bade him destroy them. At first the boy refused, but being afraid of this terrible being, he destroyed all but the cross he held in his hand.

Although the Enemy rolled his eyes and looked very terrible, yet he could not persuade the boy to obey him. Presently a bright light appeared in the sky, and the fairy Colina, queen of the fairies, descended, and seizing the boy by the hair of his head, carried him off to her palace. There he became a general favourite, and the fairy queen chose him for her bridegroom.†

In Naples the good people had a superstitious belief in a little being called the Monk of Monaciello. He is described as a little man, dressed like a monk and wearing a broad-brimmed hat. He appears to people during the night, and beckons them to follow him. If they have the courage to do so, he leads them to a place where great treasures are concealed, and in this way people have become suddenly rich.‡

This little being resembles the Spanish Duende, or house-sprites, who are mischievous and spiteful, often pelting people with sticks and stones.

Although very little is known about the fairy folk-lore of Spain, yet it shows a strong resemblance to the folk lore of France, Italy, and even Germany.

In Catalonia there is said to be a deep lake on the summit of a mountain. If a stone is thrown into this lake, a terrible storm rages, and the waters bubble and boil in a most alarming way. This may be the lake of boiling pitch referred to in the story of "Don Quixote," under which a fair princess was imprisoned. At the bottom of this lake there is a palace with a wide gate, through which none enter but the demons and their captives and the fairies who inhabit this place.

Many years ago a man was annoyed by a little girl, who was crying, and he wished that the demons would be off with her. Instantly she vanished, clutched by invisible hands, and it was seven years before she was seen again. She came as she went, "like a sudden gust of wind." She was tall in stature, but wasted and dirty, her eyes rolling wildly, and her speech inarticulate.

Possibly the demons were some kind of fairies, or the spirits of fallen angels, according to the Spanish belief. This may account for a strange request, once made by a fairy, whom a mortal had chosen for his bride. She imposed the condition that a holy name should never be mentioned in her presence, to which her husband agreed. Unfortunately, seeing one day some dogs quarrelling over a bone, he exclaimed,

"Holy Mary! Did you ever see the like?" At once the beautiful fairy bride glided through the air, and disappeared in her mountain home.

Many years after her husband was thrown into prison by the Moors, and being told that his wife alone could save him, he sent their son to her. As the boy approached the well-known mountain, "behold! his fairy mother stood there before him on the summit of a rock."

She gave him a steed called Pardalo, and bade Iniquez mount him, and not unsaddle or unbridle him nor put shoes upon his feet, and in one day the steed would carry him to Toledo. He did as he was told and rescued his father, but his mother never returned to their home.

Many stories are told about the little beings who haunt the woods, and who are sometimes seen and heard by fortunate mortals.

Pepito El Corcovado, a lively little hunchback, was returning home one evening from a wedding, where he had been playing his guitar and singing. He lost his way in the woods, and, as night was coming on, he wrapped his cloak around him, and fell asleep at the foot of a cork tree.

All at once he was awakened by the sound of little voices singing a well-known air. They would only sing the first line, but Pepito joined in and sang the whole strain. The little folks were so delighted, that, as a reward, they made him straight as a poplar, and his hump disappeared for ever.

* Keightley's "Fairy Mythology," p. 452.

† "Italian Popular Tales." T. F. Crane, p. 136.

‡ The Monaciello is closely akin to the German Nis or Kobold, which may be accounted for by the fact that the Normans settled in Naples. Keightley's "Fairy Mythology," p. 450.

ON LIFE-RESTORING.

BY PROFESSOR PREYER.*

(*Extracted from "The Open Court."*)

IF we were able to freeze a plant or animal's body through and through, to dry one up thoroughly, to preserve one for a year wholly apart from the air in a cold exhausted space without food and without water, so that on an appointed day, after the admission of moist air, it would start up in the heat and continue to live without the least injury to its health—just as if

* Translated from the German by F. W. Morton.

nothing had happened—then our methods of investigating living bodies would be essentially simplified, and we might hope to establish the necessary conditions for each separate function.

This production of life at pleasure, this winding up and stopping the clock of life, is in some cases subject to the will of man. Nature herself performs the experiment millions of times, on a large scale or on a small one, on plants and animals, on seeds and eggs, as well as on completely formed beings, when in summer it dries up the organic dust and then after weeks of drought restores it to life by invigorating rains, or when by currents of air nature transplants it to damp regions and awakens it to new life.

The unwearying Leeuwenhoek was the first to make these fundamental observations. In his 144th letter on the revealed mysteries of nature he describes a series of infusoria, especially radiate animals, which on August 25, 1701, he found in the water of a house gutter. This water he evaporated, and when, as late as February 1702, he took up the dry residue, he saw, to his great astonishment, that without exception the infusoria came to life again on being moistened with pure rain water. He thought that all the species resuscitated by him had thick shells which in the process of drying did not permit the water in the interior to evaporate. But this view, which was shared by later scientists, is incorrect, because the surrounding skin or shell—which does not exist on all species—is not so thick as would be required for this. The animals rather shrink enormously, as may easily be seen with powerful magnifying glasses, so that they become unrecognisable and evidently do not contain water within the crust or shell. It is also possible in fifty-seven other infusoria, especially in dried *ursuli*, to note the swelling of the body and the extremities when they are moistened. This is one of the most beautiful spectacles which the microscope affords, for we *see* how the supposed particles of dust which only an adept can distinguish from the surrounding real dust, and then principally by their colour, are brought into life.

The second observer was Turbervill Needham. In the summer of 1743 he discovered in diseased wheat little eel-like bodies which were wholly motionless and formed a thick confused mass. He moistened them, so as better to observe the supposed fibres, and was highly surprised when they thereupon became alive. He was greatly perplexed at this accidentally discovered fact. He kept the mites for two years in a dry place, and ever and again they would come to life through the influence of water. His observations were confirmed and extended in the same year by Henry Baker. This scientist saw the dried animals come to life by moistening after the lapse of twenty-seven years, just as after a few years. Similar results in respect to the same subject were attained somewhat later by Buffon, who established his priority against the great physiologist Fontana, who, independently of all others, made the same discovery in 1767. Buffon's account, however, is somewhat poor; and when he correctly observed and compared the anguillulæ with little machines, he confused this good thought by his broader, phantastic statements respecting the living molecules.

Fontana, with brilliant success, extended his attempts at resuscitation to other animals. He dried, besides the anguillulinæ, especially radiate animals, a hair worm, and then brought it to life again by means of water. He felt called upon "to speak of this little wonder in a special treatise under the title, 'On the Life and Apparent Death of Animals.'" This treatise, however, is not extant.

The most extensive investigations respecting the resuscitation of lifeless animals were made by Spallanzani, who, in 1776, published in Modena his great work on animal and plant physics. By drying them he could make the same rotifers lifeless, and by moistening them restore them to life eleven times. He found further that even at 19° below the freezing point of water and at a comparatively stronger degree of heat the dried animals still retained vitality. He it was who discovered the *ursuli*, which are especially serviceable for such experiments, and which, being equipped with nerves, muscles, and eyes, are far more highly organised than any other animals revivified by him.

This remarkable creature was first experimented with by C. A. S. Schultze, the first German scientist who turned his attention to the resuscitation of life. Discovered in Holland, confirmed in England and France, extended and more accurately established in Italy, the fact of revivifying small organisms made the rounds of half Europe without even a *single* fundamental investigation being made in Germany during more than a century. And after Schultze had published his observations in 1834 the fact was doubted by German scientists, and indeed utterly denied by Ehrenberg. In 1838, therefore, Schultze, on the occasion of a scientific convention in Freiburg, again set forth his discoveries. Here he showed those animals which had been called shell-animals, by Hufeland, but which he had named *macrobiotus* on account of their longevity. But Ehrenberg's strange explanation that presumably the supposed reanimated individuals were the descendants of the dried ones still for a long time kept scientists from accepting the new views.

Above all, the experiments with freezing are convincing. These can be performed with success on higher animals. Frogs, as I myself have repeatedly shown, can be frozen in all conditions to solid ice, so that the slightest trace of life no longer exists, so that no sign of vitality can be elicited from them by the greatest irritation, and then again come to life after having been thawed out, and appear just as before the experiment. Duméril, in 1852, performed such an experiment with entire success. Many fishes, we know, especially the pike, can be frozen through and through or be left lying in the air, and still be revived on being moistened with water.

With warm-blooded animals only a very few experiments of this sort have been tried. Still it is known that a few may be frozen even to the entire cessation of the heart's action and breathing, even to the complete disappearance of nervous and muscular sensibility, and then by careful heating become, for a time at least, alive again. And the chicken in the egg, before hatching, can be so greatly reduced in temperature that the action of the heart ceases, without suffering injury, if after a couple of days the normal heat is restored. It merely hatches so much smaller, since it cannot regain the lost time. Fresh eggs, again, which have been frozen to solid ice, have developed, after gradual thawing, with complete regularity in the process of incubation.

Reviews.

British Reptiles and Batrachians. By Catherine C. Hopley. (London: Swan Sonnenschein & Co. 1888.)—We shall be much surprised if the persual of Miss Hopley's most interesting volume does not lead to the setting up of reptilian vivaria by a large number of people who, prior to reading it, classed toads, frogs, lizards, and newts generally as "horrid things," and who have fled from every snake which they were unable to kill in the wildest alarm. This her latest addition to the capital "Young Collector" series fully sustains the reputation of that excellent issue,

and should be read by all who wish to know something of forms of life at present unfamiliar to a large proportion of people on account of the superstitious horror of and prejudice against them which seemingly forms part of our inheritance. We strongly advise our readers to purchase and study this absurdly cheap little work.

The Mechanic's Workshop Handybook. By PAUL N. HASLUCK, A.I.M.E. (London: Crosby Lockwood & Son. 1888.)—Mr. Hasluck's latest volume will be found alike useful by the artificer and the amateur. Dealing with the manipulation of metals, it enters in detail on such subjects as alloys, forging, welding, annealing and hardening, soldering, lacquering, drilling, filing, grinding, &c. Five pages and a half of index in very small type may suffice to indicate what a mass of diverse information is packed between the two covers of the volume before us.

Electroplating. By J. W. URQUHART, C.E. Second Edition. (London: Crosby Lockwood & Son. 1888.)—Like all the Messrs. Crosby Lockwood's publications, the one before us is eminently practical, and may be studied with advantage at once by the amateur and by the professional worker in the plating-shop. Batteries, dynamos, baths, &c. &c., are carefully and intelligibly described, while the special methods employed in the electro-deposition of the various metals are excellently explained in detail. Mr. Urquhart has produced a work of enduring value.

THE FACE OF THE SKY FOR NOVEMBER.

By F.R.A.S.

THE sun may be watched for the small spots which appear at distant intervals on his surface. Map xi. of "The Stars in their Seasons" exhibits the aspect of the night sky. Minima of the variable star Algol ("The Stars in their Seasons," map xii.) will happen on November 2 at 5h. 17m. P.M.; on the 17th at 1h. 22m. A.M.; on the 19th at 10h. 11m. P.M.; and on the 22nd at 7h. P.M., as well as on other occasions less convenient for observation. The student should watch (*after midnight*) on the nights from the 12th to the 14th for the shower of shooting stars radiating from the "sickle" of Leo. He may also look out on the night of the 27th; in fact, November is a month prolific in these visitants from space. Mercury is a morning star all through November, and attains his greatest elongation (19° 26′) west of the sun on the morning of the 17th. Towards the end of the month he may be seen with the naked eye in the SE. by E. before sunrise. Venus is an evening star, but her south declination is so great that she is visible with difficulty, if at all. Mars and Jupiter are both invisible, as is Uranus also. Saturn may be seen in the eastern sky by midnight to the WNW. of Regulus ("The Stars in their Seasons," map iii.). Neptune is in Taurus a little to the west, and just to the south of the 6th magnitude star ω^1 in that constellation a line drawn from Aldebaran through δ Tauri ("The Stars in their Seasons," map i.) if prolonged rather more than as far again will pass pretty close to Neptune's place. The moon is new 2·4m. after midnight on the 3rd; enters her first quarter at 4h. 15·8m. P.M. on the 10th; is full at 3h. 15·9m. P.M. on the 18th; and enters her last quarter at 5h. 20·5m. P.M. on the 26th. Four occultations of fixed stars by the moon will occur at fairly convenient hours during the present month. The first happens on November 6, when B.A.C. 5954, a star of the 6th magnitude, will disappear at the moon's dark limb at 6h. 13m. P.M., at an angle of 75° from her vertex; but she will have set ere it reappears. On the 12th, ψ^3 Capricorni, a 5th magnitude star, will disappear at 5h. 9m. P.M. at the dark limb of the moon, at an angle from her vertex of 103°. It will reappear at her bright limb at 6h. 24m. P.M., at a vertical angle of 267°. On the 19th, *i* Tauri, of the 5½th magnitude, will disappear at the bright limb of the moon at 9h. 57m. P.M., at an angle of 153° from her vertex; reappearing at her dark limb at 10h. 9m. P.M., at an angle from her vertex of 174°. Lastly, on the 21st, 15 Geminorum, a star of the 6th magnitude, will disappear at the moon's bright limb at 7h. 15m. P.M., at a vertical angle of 346°. Its reappearance at the dark limb will happen at 7h. 29m. P.M., at an angle of 315° from the vertex of the moon. The moon is in Virgo at noon to-day ("The Seasons Pictured," plate xxv.), and is travelling across that great constellation until 2h. P.M. on the 3rd, when she enters Libra ("The Seasons Pictured," plate xxvi.). As she crosses Libra she arrives, at 4h. 30m. A.M. on the 5th, on the western edge of the narrow northern spike of Scorpio; by 1h. P.M. on the same day she has traversed this and emerged in Ophiuchus. By 11 P.M. on the 6th the journey over Ophiuchus is completed, and she passes into Sagittarius. Here she remains until 5h. 30m. A.M. on the 9th, at which hour she quits Sagittarius for Capricornus ("The Seasons Pictured," plate xxi.), which she leaves in turn for Aquarius at 2h. 30m. A.M. on the 11th. She remains in Aquarius until 6h. A.M. on the 13th, and then crosses into Pisces ("The Seasons Pictured," plate xxii.). Travelling through Pisces, she enters the north-western part of Cetus at midnight. She re enters Pisces at 9 A.M. on the 15th, only, however, to plunge again into Cetus at 8h. A.M. on the 16th, whence, at midnight of the same day, she passes into Aries ("The Seasons Pictured," plate xxiii.). She remains in Aries until 3h. A.M. on the 18th, and then leaves it for Taurus. Journeying across Taurus, we find her, at 5h. A.M. on the 21st., close to the northernmost portion of Orion. By 2h. 30m. the same afternoon she has traversed this and emerged in Gemini ("The Seasons Pictured," plate xxiv.). At 2h. P.M. on the 23rd she passes out of Gemini into Cancer, leaving Cancer in turn for Leo at 5h. A.M. on the 25th. She is travelling across Leo until 11h. P.M. on the 27th, when she crosses the boundary into Virgo ("The Seasons Pictured," plate xxv.). She is close to the confines of Virgo and Libra at midnight on the 30th.

Our Chess Column.

By "MEPHISTO."

CHESS IN HOLLAND.

THE following fine games were recently played at Amsterdam. The openings, in both cases, are interesting specimens of two of the best and most difficult variations in the Spanish *début*, and the middle and end-game is of a brilliant and pleasing character, doing credit to both victor and vanquished. It may be stated that Mr. Loman, the winner, has recently won the first prize in the Dutch National Tournament, but that he has lost a majority of games against Herr D. van Foreest, his unsuccessful opponent in the two games given below:—

SPANISH.

WHITE. R. Loman.	BLACK. D. van Foreest.
1. P to K4	1. P to K4
2. Kt to KB3	2. Kt to QB3
3. B to Kt5	3. P to QR3
4. B to R4	4. Kt to B3
5. Castles	5. Kt × P
6. P to Q4	6. P to QKt4
7. B to Kt3	7. P to Q4
8. P to QR4	

Played by Tchigorin against Rosenthal in 1883. It seems to be the natural continuation against the weakened Queen's side.

8. P to Kt5

This move creates still more looseness in Black's position, particularly as he has not yet Castled, and in similar positions it is always doubtful whether the weakened party will get the time for bringing his King into safety. We would prefer QR to Ktsq, but not without misgivings as to the future prospects.

9. P to R5 — 9. P × P

White threatened P × P, and to win the QP afterwards.

10. Kt × P

If 10. B to R4 instead, Black defends with B to Q2. 11. B × Kt, B × B. 12. Kt × P, B to Q2. 13. P to KB3, Kt to B4, &c.

10. Kt × Kt

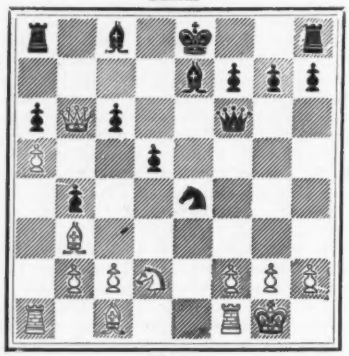
11. Q × Kt	11. P to QB3
12. Kt to Q2	12. Q to B3
13. Q to Kt6	13. B to K2

Up to White's last move the position is identical with the above-mentioned game, but Rosenthal here played Kt × Kt instead of Black's move of B to K2. It is interesting to note that Mr. Wayte, remarking on Black's 13th move of Kt × Kt said, If, instead, 13. . . . B to K2, 14. Kt × Kt, P × Kt, 15. B to Kt5! This actually happened in this case, and speedily turned the game in White's favour. Of course, if Black plays Kt × Kt, 14. B × Kt, and he loses the QKtP.

XUM

Position after Black's thirteenth move, B to K2!

BLACK.



WHITE.

14. Kt × Kt	14. P × Kt
15. B to Kt5!	15. B to Qsq

If Q to Kt3, then after 16. B × B, K × B, 17. Q × P (ch), White has a winning position.

16. Q to B5	16. B to K2
17. Q to B4	

And the game terminated in White's favour as per above note.

WHITE. R. Loman.	BLACK. D. van Foreest.
1. P to K4	1. P to K4
2. Kt to KB3	2. Kt to QB3
3. B to Kt5	3. Kt to B3
4. Castles	4. Kt × P
5. P to Q4	5. B to K2
6. Q to K2	6. Kt to Q3
7. B × Kt	7. KtP × B
8. P × P	8. Kt to Kt2
9. Kt to Q4	9. Kt to B4
10. R to Qsq	10. B to Kt2
11. Kt to B3	11. Castles

So far again all is book, but we do not at all like this variation, especially if the Black QB has to play to Kt2, which enables White to proceed more freely against the King's side by Q to Kt4, as he is not threatened with P to Q4.

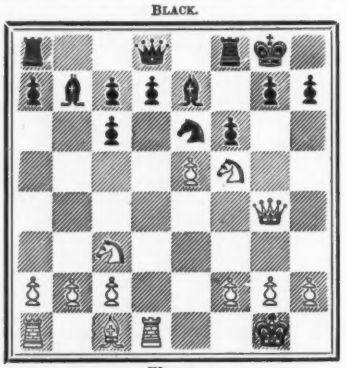
12. Q to Kt4	12. P to KB3

This move at times turns out well for Black. There is, however, always a certain amount of danger in it. In the present instance, K to Rsq seems the safest move.

13. Kt to B5	13. Kt to K3

Position after Black's thirteenth move, Kt to K3.

BLACK.



WHITE.

14. Kt × P

Very good move. White's attack against the King's side always proceeds on similar lines in this opening, though the moves may vary. A similar game was played by Locock against Gunsberg in the recent Bradford Tournament, the former player very nearly carrying the assault to a fatal termination for Black. For the sake of comparison we give this game below.

	14. Kt × Kt
15. B to R6	15. R to B2
16. P to K6	16. P × P

Black must give up his Queen, as otherwise he will be worse off.

17. R × Q	R × R	24. R to K6	P to B5
18. B × Kt	R × B	25. Kt to K4	P × P
19. Q × P (ch)	K to Rsq	26. RP × P	P to B4
20. R to Qsq	R to KBsq	27. Kt to B6	B to K2
21. R to Ksq	B to Q3	28. Q to QB3	B × Kt
22. P to KKt3	P to KB4	29. R × B	R to Qsq
23. Q to Kt3	B to Rsq	30. K to R2	Resigns

White has conducted the game soundly and effectively. Black has not much chance left.

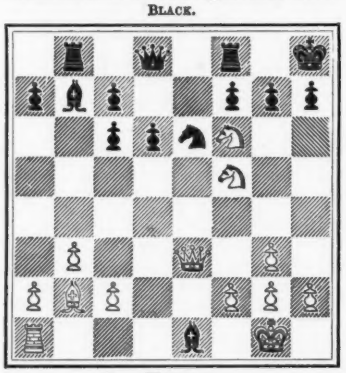
PLAYED AT THE BRADFORD TOURNAMENT.

WHITE. Locock.	BLACK. Gunsberg.	WHITE. Locock.	BLACK. Gunsberg.
1. P to K4	P to K4	11. R to Ksq	R to Ktsq
2. Kt to KB3	Kt to QB3	12. P to QKt3	Kt to K3
3. B to Kt5	Kt to B3	13. Kt to B5	B to Kt5
4. Castles	B to K2	14. Q to K3	P to Q4
5. P to Q4	Kt × KP	15. P × P *en pas*	P × P
6. Q to K2	Kt to Q3	16. B to Kt2	B to Kt2
7. B × Kt	KtP × B	17. Kt to K4	B × R
8. P × P	Kt to Kt2	18. Kt to B6 (ch)	K to Rsq
9. Kt to Q4	Castles	19. Q to R6	
10. Kt to QB3	Kt to B4		

White's last move was a miscalculation. He imagined that, after P × Q, he could proceed with 20. Kt, discovers check K to Ktsq; 21. Kt × P mate, overlooking that Black could interpose his P on B3. White had a very good continuation in Kt × P, as may be seen on examination of the position given in the following diagram:—

Position after Black's eighteenth move.

BLACK.



WHITE.

If White plays 19. Kt × KtP, Black cannot retake with Kt on account of 20. Q to R6. Also if 19. K × Kt Black would be mated by 20. Q to Kt3 (ch), K to Rsq, 21. Q to R4. The only move for Black to prevent Q to R6 seems to be 19. . . . B × P (ch), 20. K × B, Q to Kt3; 21. Q × Q, P × Q; 22. Kt to B5, and White should win.

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